Series GEFH1/1

SET ~ 1

प्रश्न-पत्र कोड
Q.P. Code **55/1/1**

रोल नं.
Roll No.

परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।
Candidates must write the Q.P. Code on the title page of the answer-book. *

भौतिक विज्ञान (सैद्धान्तिक)
PHYSICS (Theory)

निर्धारित समय : 3 घण्टे | *अधिकतम अंक : 70*

Time allowed : 3 hours | *Maximum Marks : 70*

नोट / NOTE :

(i) कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **27** हैं ।
Please check that this question paper contains **27** printed pages.

(ii) प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।
Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.

(iii) कृपया जाँच कर लें कि इस प्रश्न-पत्र में **35** प्रश्न हैं ।
Please check that this question paper contains **35** questions.

(iv) **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में प्रश्न का क्रमांक अवश्य लिखें ।**
Please write down the serial number of the question in the answer-book before attempting it.

(v) इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा । 10.15 बजे से 10.30 बजे तक छात्र केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।
15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.

सामान्य निर्देश :

निम्नलिखित निर्देशों को बहुत सावधानी से पढ़िए और उनका सख़्ती से पालन कीजिए :

(i) *इस प्रश्न-पत्र में* ***35*** *प्रश्न हैं ।* ***सभी*** *प्रश्न* ***अनिवार्य*** *हैं ।*

(ii) *यह प्रश्न–पत्र* ***पाँच*** *खण्डों में विभाजित है –* ***क, ख, ग, घ*** *एवं* ***ङ*** *।*

(iii) ***खण्ड क*** *में प्रश्न संख्या* ***1*** *से* ***18*** *तक बहुविकल्पीय (MCQ) प्रकार के* ***एक-एक*** *अंक के प्रश्न हैं ।*

(iv) ***खण्ड ख*** *में प्रश्न संख्या* ***19*** *से* ***25*** *तक अति लघु-उत्तरीय (VSA) प्रकार के* ***दो-दो*** *अंकों के प्रश्न हैं ।*

(v) ***खण्ड ग*** *में प्रश्न संख्या* ***26*** *से* ***30*** *तक लघु-उत्तरीय (SA) प्रकार के* ***तीन-तीन*** *अंकों के प्रश्न हैं ।*

(vi) ***खण्ड घ*** *में प्रश्न संख्या* ***31*** *से* ***33*** *तक दीर्घ-उत्तरीय (LA) प्रकार के* ***पाँच-पाँच*** *अंकों के प्रश्न हैं ।*

(vii) ***खण्ड ङ*** *में प्रश्न संख्या* ***34*** *तथा* ***35*** *केस-आधारित* ***चार-चार*** *अंकों के प्रश्न हैं ।*

(viii) *प्रश्न–पत्र में समग्र विकल्प नहीं दिया गया है । यद्यपि, खण्ड ख के 2 प्रश्नों में, खण्ड ग के 2 प्रश्नों में, खण्ड घ के 3 प्रश्नों में तथा खण्ड ङ के 2 प्रश्नों में आंतरिक विकल्प का प्रावधान दिया गया है ।*

(ix) *कैल्कुलेटर का उपयोग* ***वर्जित*** *है ।*

भौतिक नियतांकों के निम्नलिखित मान, आवश्यकता अनुसार उपयोग करें :

$c = 3 \times 10^8$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

इलेक्ट्रॉन का द्रव्यमान (m_e) = $9{\cdot}1 \times 10^{-31}$ kg

न्यूट्रॉन का द्रव्यमान = $1{\cdot}675 \times 10^{-27}$ kg

प्रोटॉन का द्रव्यमान = $1{\cdot}673 \times 10^{-27}$ kg

आवोगाद्रो संख्या = $6{\cdot}023 \times 10^{23}$ प्रति ग्राम मोल (per gram mole)

बोल्ट्ज़मान नियतांक = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

General Instructions :

Read the following instructions very carefully and strictly follow them :

(i) *This question paper contains **35** questions. **All** questions are **compulsory**.*

(ii) *This question paper is divided into **five** Sections – **A, B, C, D** and **E**.*

(iii) *In **Section A** – Questions no. **1** to **18** are Multiple Choice (MCQ) type questions, carrying **1** mark each.*

(iv) *In **Section B** – Questions no. **19** to **25** are Very Short Answer (VSA) type questions, carrying **2** marks each.*

(v) *In **Section C** – Questions no. **26** to **30** are Short Answer (SA) type questions, carrying **3** marks each.*

(vi) *In **Section D** – Questions no. **31** to **33** are Long Answer (LA) type questions carrying **5** marks each.*

(vii) *In **Section E** – Questions no. **34** and **35** are case-based questions carrying **4** marks each.*

(viii) *There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 2 questions in Section C, 3 questions in Section D and 2 questions in Section E.*

(ix) *Use of calculators is **not** allowed.*

Use the following values of physical constants, if required :

$c = 3 \times 10^8$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ $C^2 N^{-1} m^{-2}$

$$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$$

Mass of electron (m_e) = $9{\cdot}1 \times 10^{-31}$ kg

Mass of neutron = $1{\cdot}675 \times 10^{-27}$ kg

Mass of proton = $1{\cdot}673 \times 10^{-27}$ kg

Avogadro's number = $6{\cdot}023 \times 10^{23}$ per gram mole

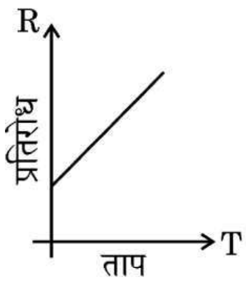
Boltzmann constant = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

खण्ड क

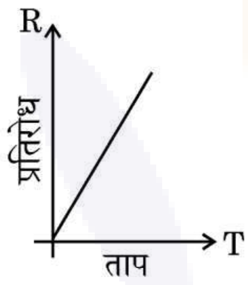
1. किसी लघु विद्युत द्विध्रुव के अक्ष पर उससे ‘r’ दूरी पर स्थित कोई बिन्दु आवेश $\vec{F}$ बल का अनुभव करता है । यदि आवेश की दूरी ‘2r’ है, तो आवेश द्वारा अनुभव किया जाने वाला बल होगा :

(a) $\frac{\vec{F}}{16}$ (b) $\frac{\vec{F}}{8}$ (c) $\frac{\vec{F}}{4}$ (d) $\frac{\vec{F}}{2}$

2. किसी धात्विक चालक के लिए, ताप T के साथ प्रतिरोध R के सही विचरण को निरूपित करने वाला ग्राफ है :



(a)



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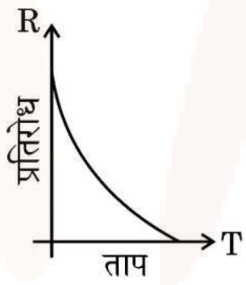

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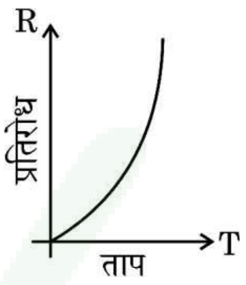
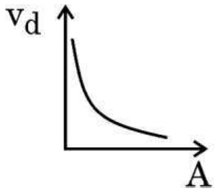


(d)

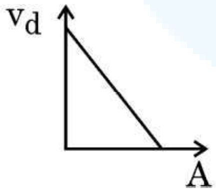
3. किसी खुले परिपथ में किसी सेल के सिरों के बीच विभवान्तर 8 V है । जब इस सेल से 4 A धारा ली जाती है तो विभवान्तर घटकर 4 V हो जाता है । इस सेल का आन्तरिक प्रतिरोध है :

(a) 4 Ω (b) 3 Ω (c) 2 Ω (d) 1 Ω

4. किसी धातु के तार, जिसकी अनुप्रस्थ-काट का क्षेत्रफल (A) एक सिरे से दूसरे सिरे तक निरन्तर बढ़ रहा है, से कोई स्थायी धारा प्रवाहित हो रही है । ‘A’ के फलन के रूप में मुक्त इलेक्ट्रॉनों के अपवाह वेग (v_d) के परिमाण को दर्शाया जा सकता है :



(a)



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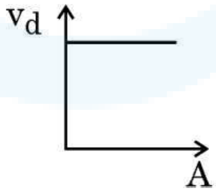

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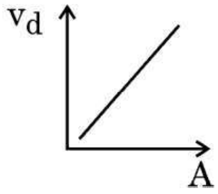


(d)

5. किसी प्रतिचुम्बकीय पदार्थ को किसी छड़ चुम्बक के उत्तर अथवा दक्षिण ध्रुव के निकट लाया गया है । यह पदार्थ :

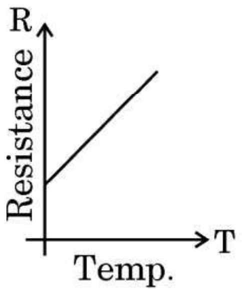
(a) दोनों ध्रुवों द्वारा प्रतिकर्षित किया जाएगा ।
(b) दोनों ध्रुवों द्वारा आकर्षित किया जाएगा ।
(c) उत्तर ध्रुव द्वारा प्रतिकर्षित तथा दक्षिण ध्रुव द्वारा आकर्षित किया जाएगा ।
(d) उत्तर ध्रुव द्वारा आकर्षित तथा दक्षिण ध्रुव द्वारा प्रतिकर्षित किया जाएगा ।

SECTION A

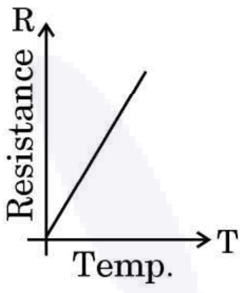
1. A point charge situated at a distance ‘r’ from a short electric dipole on its axis, experiences a force $\vec{F}$. If the distance of the charge is ‘2r’, the force on the charge will be :

(a) $\frac{\vec{F}}{16}$ (b) $\frac{\vec{F}}{8}$ (c) $\frac{\vec{F}}{4}$ (d) $\frac{\vec{F}}{2}$

2. For a metallic conductor, the correct representation of variation of resistance R with temperature T is :



(a)



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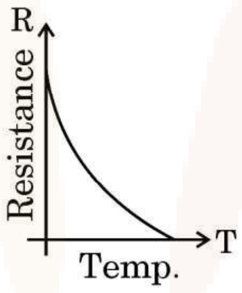

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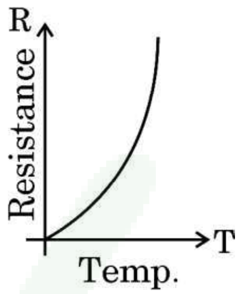
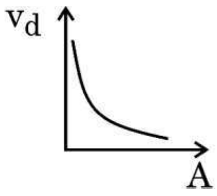


(d)

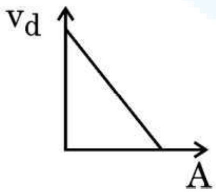
3. The potential difference across a cell in an open circuit is 8 V. It falls to 4 V when a current of 4 A is drawn from it. The internal resistance of the cell is :

(a) 4 Ω (b) 3 Ω (c) 2 Ω (d) 1 Ω

4. A steady current flows through a metallic wire whose area of cross-section (A) increases continuously from one end of the wire to the other. The magnitude of drift velocity (v_d) of the free electrons as a function of ‘A’ can be shown by :



(a)



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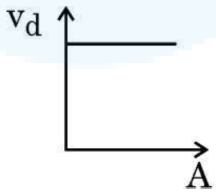
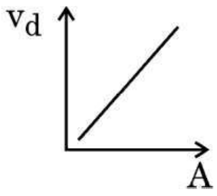


(c)



(d)

5. A diamagnetic substance is brought near the north or south pole of a bar magnet. It will be :

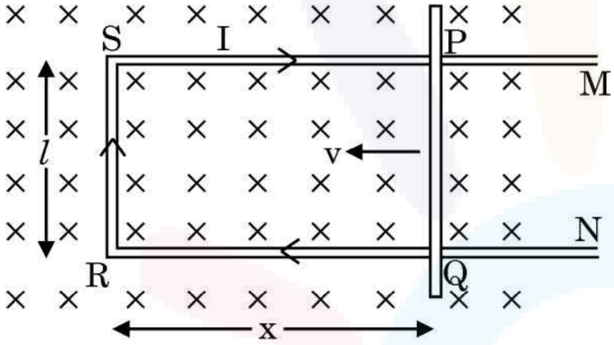
(a) repelled by both the poles.
(b) attracted by both the poles.
(c) repelled by the north pole and attracted by the south pole.
(d) attracted by the north pole and repelled by the south pole.

6. कोई वृत्ताकार कुण्डली जिसकी त्रिज्या 8·0 cm है तथा जिसमें 40 फेरे हैं, अपने ऊर्ध्वाधर व्यास के परित: $\frac{25}{\pi}$ रेडियन प्रति सेकण्ड की कोणीय चाल से $3{\cdot}0 \times 10^{-2}$ T परिमाण के किसी एकसमान क्षैतिज चुम्बकीय क्षेत्र में घूर्णन कर रही है । इस कुण्डली में प्रेरित अधिकतम वि.वा. बल (emf) है :

(a) 0·12 V (b) 0·15 V

(c) 0·19 V (d) 0·22 V

7. आरेख में किसी आयताकार चालक PSRQ को दर्शाया गया है जिसमें गतिमान भुजा PQ का प्रतिरोध 'r' है तथा PSRQ का प्रतिरोध उपेक्षणीय है । जब PQ को वेग $\vec{v}$ से गति कराई जाती है तो प्रेरित वि.वा. बल (emf) का परिमाण निम्नलिखित में से किस पर निर्भर ***नहीं*** करता है ?



(a) चुम्बकीय क्षेत्र ($\vec{B}$) (b) वेग ($\vec{v}$)

(c) प्रतिरोध (r) (d) PQ की लम्बाई

8. किसी संधारित्र को आवेशित करने की प्रक्रिया में, संधारित्र की पट्टिकाओं के बीच उत्पन्न विद्युत धारा होती है :

(a) $\mu_0 \frac{d\phi_E}{dt}$ (b) $\frac{1}{\mu_0}\frac{d\phi_E}{dt}$

(c) $\varepsilon_0 \frac{d\phi_E}{dt}$ (d) $\frac{1}{\varepsilon_0}\frac{d\phi_E}{dt}$

यहाँ प्रतीकों के सामान्य अर्थ हैं ।

9. फोकस दूरी 'f' के किसी अवतल दर्पण के लिए बिम्ब और उसके वास्तविक प्रतिबिम्ब के बीच की न्यूनतम दूरी होती है :

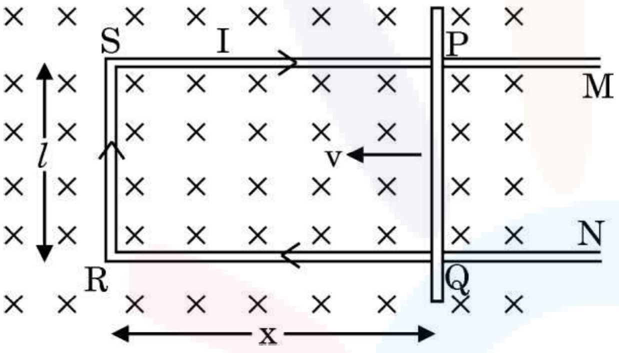
(a) शून्य (b) f

(c) 2f (d) 4f

6. A circular coil of radius 8·0 cm and 40 turns is rotated about its vertical diameter with an angular speed of $\frac{25}{\pi}$ rad s^{-1} in a uniform horizontal magnetic field of magnitude $3 \cdot 0 \times 10^{-2}$ T. The maximum emf induced in the coil is :

(a)	0·12 V	(b)	0·15 V
(c)	0·19 V	(d)	0·22 V

7. Figure shows a rectangular conductor PSRQ in which movable arm PQ has a resistance 'r' and resistance of PSRQ is negligible. The magnitude of emf induced when PQ is moved with a velocity $\vec{v}$ does ***not*** depend on :



(a)	magnetic field ($\vec{B}$)	(b)	velocity ($\vec{v}$)
(c)	resistance (r)	(d)	length of PQ

8. In the process of charging of a capacitor, the current produced between the plates of the capacitor is :

(a)	$\mu_0 \frac{d\phi_E}{dt}$	(b)	$\frac{1}{\mu_0} \frac{d\phi_E}{dt}$
(c)	$\varepsilon_0 \frac{d\phi_E}{dt}$	(d)	$\frac{1}{\varepsilon_0} \frac{d\phi_E}{dt}$

where symbols have their usual meanings.

9. For a concave mirror of focal length 'f', the minimum distance between the object and its real image is :

(a)	zero	(b)	f
(c)	2f	(d)	4f

10. हाइड्रोजन परमाणु के बोर मॉडल में nवीं कक्षा की त्रिज्या निम्नलिखित में से किसके समानुपाती होती है ?

(a) $\frac{1}{n^2}$ (b) $\frac{1}{n}$

(c) n^2 (d) n

11. हाइड्रोजन परमाणु अपनी आरम्भिक निम्नतम अवस्था में किसी फोटॉन को अवशोषित करता है जो उसे n = 5 स्तर तक उत्तेजित कर देता है । इस फोटॉन की तरंगदैर्ध्य है :

(a) 975 nm (b) 740 nm

(c) 523 nm (d) 95 nm

12. द्रव्यमान संख्या A के नाभिक का द्रव्यमान घनत्व :

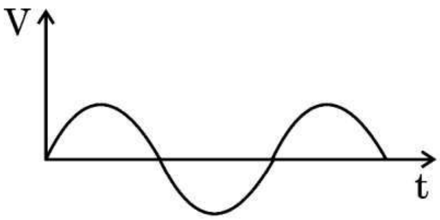
(a) $A^{1/3}$ के समानुपाती होता है

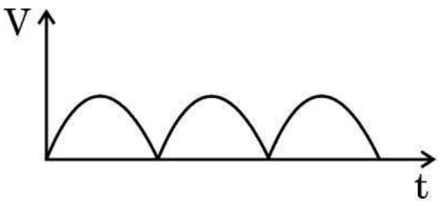
(b) $A^{2/3}$ के समानुपाती होता है

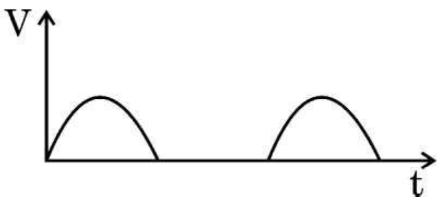
(c) A^3 के समानुपाती होता है

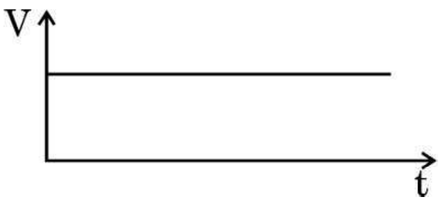
(d) A पर निर्भर नहीं करता है

13. वोल्टेज का कोई ac स्रोत श्रेणी में किसी p-n संधि डायोड और लोड प्रतिरोधक से संयोजित है । लोड प्रतिरोध के सिरों पर निर्गत वोल्टता के लिए सही विकल्प होगा :

(a)


(b)


(c)


(d)


10. The radius of the n^{th} orbit in Bohr model of hydrogen atom is proportional to :

(a) $\frac{1}{n^2}$ (b) $\frac{1}{n}$

(c) n^2 (d) n

11. Hydrogen atom initially in the ground state, absorbs a photon which excites it to n = 5 level. The wavelength of the photon is :

(a) 975 nm (b) 740 nm

(c) 523 nm (d) 95 nm

12. The mass density of a nucleus of mass number A is :

(a) proportional to $A^{1/3}$

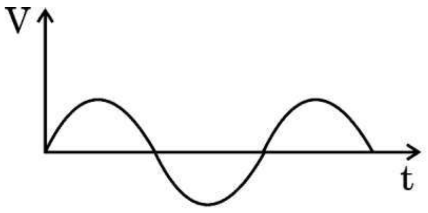
(b) proportional to $A^{2/3}$

(c) proportional to A^3

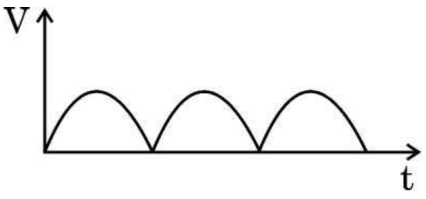
(d) independent of A

13. An ac source of voltage is connected in series with a p-n junction diode and a load resistor. The correct option for output voltage across load resistance will be :

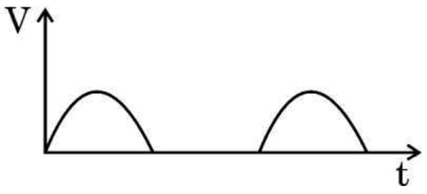
(a)



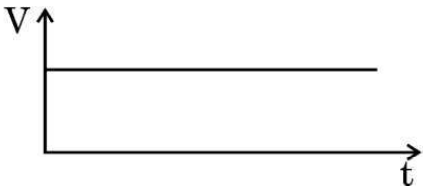
(b)



(c)



(d)



14. जब किसी नैज अर्धचालक को किसी त्रिसंयोजी अशुद्धि की अल्प मात्रा से मादित किया जाता है, तो :

(a) उसका प्रतिरोध बढ़ जाता है ।

(b) यह p-प्रकार का अर्धचालक बन जाता है ।

(c) उस अर्धचालक में मुक्त इलेक्ट्रॉन विवरों (होल) से अधिक होते हैं ।

(d) मादक (अपमिश्रक) परमाणु दाता परमाणु बन जाते हैं ।

15. n-प्रकार के Si के ऊर्जा-बैण्ड आरेख में, चालन बैण्ड की तली E_C और दाता ऊर्जा स्तर E_D के बीच अन्तराल की कोटि होती है :

(a) 10 eV

(b) 1 eV

(c) 0·1 eV

(d) 0·01 eV

*प्रश्न संख्या **16** से **18** अभिकथन (A) और कारण (R) प्रकार के प्रश्न हैं । दो कथन दिए गए हैं — जिनमें एक को अभिकथन (A) तथा दूसरे को कारण (R) द्वारा अंकित किया गया है । सही उत्तर नीचे दिए गए कोडों (a), (b), (c) और (d) में से चुनकर दीजिए ।*

(a) अभिकथन (A) और कारण (R) दोनों सही हैं और कारण (R), अभिकथन (A) की सही व्याख्या करता है ।

(b) अभिकथन (A) और कारण (R) दोनों सही हैं, परन्तु कारण (R), अभिकथन (A) की सही व्याख्या ***नहीं*** करता है ।

(c) अभिकथन (A) सही है, परन्तु कारण (R) ग़लत है ।

(d) अभिकथन (A) ग़लत है तथा कारण (R) भी ग़लत है ।

16. *अभिकथन (A) :* जब किसी कॉपर की छड़ को किसी बाहरी चुम्बकीय क्षेत्र में रखा जाता है, तो क्षेत्र रेखाएँ उस छड़ के भीतर सांद्रित हो जाती हैं ।

कारण (R) : कॉपर एक अनुचुम्बकीय पदार्थ है ।

14. When an intrinsic semiconductor is doped with a small amount of trivalent impurity, then :

(a) its resistance increases.

(b) it becomes a p-type semiconductor.

(c) there will be more free electrons than holes in the semiconductor.

(d) dopant atoms become donor atoms.

15. In the energy-band diagram of n-type Si, the gap between the bottom of the conduction band E_C and the donor energy level E_D is of the order of :

(a) 10 eV

(b) 1 eV

(c) 0·1 eV

(d) 0·01 eV

*Questions number **16** to **18** are Assertion (A) and Reason (R) type questions. Two statements are given — one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (a), (b), (c) and (d) as given below.*

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is ***not*** the correct explanation of the Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false and Reason (R) is also false.

16. *Assertion (A) :* When a bar of copper is placed in an external magnetic field, the field lines get concentrated inside the bar.

Reason (R) : Copper is a paramagnetic substance.

17. *अभिकथन (A) :* किसी तरंगाग्र के किन्हीं दो बिन्दुओं के बीच कलान्तर शून्य होता है ।

कारण (R) : किसी तरंगाग्र के सभी बिन्दु स्रोत से समान दूरी पर होते हैं और इस प्रकार समान कला में दोलन करते हैं ।

18. *अभिकथन (A) :* प्रकाश-विद्युत प्रभाव प्रकाश की कणात्मक प्रकृति को निदर्शित करता है ।

कारण (R) : देहली आवृत्ति से अधिक आवृत्तियों के लिए प्रकाश-विद्युत धारा आपतित विकिरणों की तीव्रता के समानुपाती होती है ।

खण्ड ख

19. किसी ऐल्फा कण को वेग $\vec{v} = (3 \cdot 0 \times 10^5 \text{ m/s}) \hat{i}$ से उस क्षेत्र में प्रक्षेपित किया गया है जिसमें कोई चुम्बकीय क्षेत्र $\vec{B} = [(0 \cdot 4 \text{ T}) \hat{i} + (0 \cdot 3 \text{ T}) \hat{j}]$ विद्यमान है । इस क्षेत्र में कण का त्वरण परिकलित कीजिए । $\hat{i}$, $\hat{j}$ और $\hat{k}$ क्रमशः x, y और z अक्ष के अनुदिश एकांक सदिश हैं तथा ऐल्फा कण के लिए आवेश और द्रव्यमान अनुपात $4 \cdot 8 \times 10^7$ C/kg है । *2*

20. किसी परिवर्ती विद्युत क्षेत्र के कारण प्रेरित चुम्बकीय क्षेत्र और परिवर्ती चुम्बकीय क्षेत्र के कारण प्रेरित विद्युत क्षेत्र पर विचार कीजिए । इनमें से किसका प्रेक्षण अधिक आसानी से किया जा सकता है ? अपने उत्तर की पुष्टि कीजिए । *2*

21. (क) हाइगेंस सिद्धान्त का उपयोग करके किसी समतल तरंग का किसी दो माध्यमों को पृथक करने वाले समतल पृष्ठ पर अपवर्तन दर्शाने वाला किरण आरेख खींचिए । अपवर्तन के स्नेल के नियम का सत्यापन भी कीजिए । *2*

अथवा

(ख) अपवर्ती दूरदर्शक की तुलना में परावर्ती दूरदर्शक को प्राथमिकता क्यों दी जाती है ? दो कारण देते हुए अपने उत्तर की पुष्टि कीजिए । *2*

17. *Assertion (A) :* The phase difference between any two points on a wavefront is zero.

Reason (R) : All points on a wavefront are at the same distance from the source and thus oscillate in the same phase.

18. *Assertion (A) :* Photoelectric effect demonstrates the particle nature of light.

Reason (R) : Photoelectric current is proportional to intensity of incident radiation for frequencies more than the threshold frequency.

SECTION B

19. An alpha particle is projected with velocity $\vec{v} = (3{\cdot}0 \times 10^5 \text{ m/s})\ \hat{i}$ into a region in which magnetic field $\vec{B} = [(0{\cdot}4 \text{ T})\ \hat{i} + (0{\cdot}3 \text{ T})\ \hat{j}\,]$ exists. Calculate the acceleration of the particle in the region. $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along x, y and z axis respectively and charge to mass ratio for alpha particle is $4{\cdot}8 \times 10^7$ C/kg. *2*

20. Consider an induced magnetic field due to changing electric field and an induced electric field due to changing magnetic field. Which one is more easily observed ? Justify your answer. *2*

21. (a) Using Huygens' principle, draw a ray diagram showing the propagation of a plane wave refracting at a plane surface separating two media. Also verify Snell's law of refraction. *2*

OR

(b) Why is a reflecting telescope preferred over a refracting telescope ? Justify your answer giving two reasons. *2*

22. I और 4 I तीव्रताओं के दो एकवर्णी कलासंबद्ध प्रकाश पुन्ज एक-दूसरे पर अध्यारोपण करते हैं । परिणामी पुन्ज में अधिकतम और न्यूनतम तीव्रताओं का अनुपात ज्ञात कीजिए । *2*

23. हाइड्रोजन परमाणु की निम्नतम ऊर्जा अवस्था $-13{\cdot}6$ eV है । तृतीय उत्तेजित अवस्था में इलेक्ट्रॉन की स्थितिज ऊर्जा और गतिज ऊर्जा क्या हैं ? *2*

24. (क) नैज और अपद्रव्यी अर्धचालकों के बीच विभेदन कीजिए । *2*

अथवा

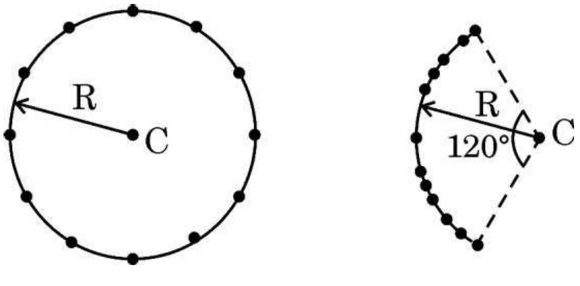
(ख) अग्रदिशिक बायस और पश्चदिशिक बायस में किसी p-n संधि डायोड के V – I अभिलाक्षणिकों का अध्ययन करने के लिए परिपथ व्यवस्था खींचिए । सिलिकॉन डायोड के V – I अभिलाक्षणिक का आलेख प्रदर्शित कीजिए । *2*

25. संक्षेप में व्याख्या कीजिए कि किसी p-n संधि डायोड में विसरण और अपवाह धाराएँ किस प्रकार रोधिका विभव के निर्माण में योगदान करती हैं । *2*

खण्ड ग

26. (क) आरेख (i) में दर्शाए अनुसार R त्रिज्या के किसी वृत्त की परिधि पर समान दूरियों पर समान परिमाण के 12 ऋणावेश स्थित हैं । अनन्त पर शून्य विभव के सापेक्ष वृत्त के केन्द्र C पर विद्युत विभव और विद्युत क्षेत्र ज्ञात कीजिए ।

(ख) यदि आरेख (ii) में दर्शाए अनुसार आवेश त्रिज्या R के 120° के चाप पर असमान दूरियों पर स्थित हैं, तो केन्द्र C पर विद्युत विभव ज्ञात कीजिए । *3*



(i) (ii)

22. Two coherent monochromatic light beams of intensities I and 4 I superpose each other. Find the ratio of maximum and minimum intensities in the resulting beam. *2*

23. The ground state energy of hydrogen atom is $-13{\cdot}6$ eV. What is the potential energy and kinetic energy of an electron in the third excited state ? *2*

24. (a) Differentiate between intrinsic and extrinsic semiconductors. *2*

OR

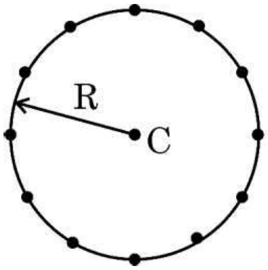
(b) Draw the circuit arrangement for studying the V – I characteristics of a p-n junction diode in forward bias and reverse bias. Show the plot of V – I characteristic of a silicon diode. *2*

25. Briefly explain how the diffusion and drift currents contribute to the formation of potential barrier in a p-n junction diode. *2*

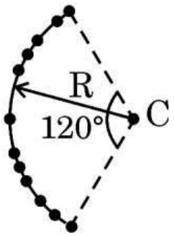
SECTION C

26. (a) Twelve negative charges of same magnitude are equally spaced and fixed on the circumference of a circle of radius R as shown in Fig. (i). Relative to potential being zero at infinity, find the electric potential and electric field at the centre C of the circle.

(b) If the charges are unequally spaced and fixed on an arc of 120° of radius R as shown in Fig. (ii), find electric potential at the centre C. *3*



(i)



(ii)

27. (क) प्रतिरोध किस प्रकार प्रतिबाधा से भिन्न है ? उपयुक्त फेज़र आरेख की सहायता से किसी श्रेणी LCR परिपथ, जो किसी स्रोत $v = v_m \sin \omega t$ से संयोजित है, की प्रतिबाधा के लिए व्यंजक प्राप्त कीजिए । *3*

अथवा

(ख) स्रोत $v = v_m \sin \omega t$, जिसमें ω को परिवर्तित किया जा सकता है, से संयोजित किसी श्रेणी LCR परिपथ के अनुनाद के लिए शर्त ज्ञात कीजिए । उन कारकों का उल्लेख कीजिए जिन पर किसी श्रेणी LCR परिपथ की अनुनाद आवृत्ति निर्भर करती है । किसी श्रेणी LCR परिपथ में आवृत्ति के साथ विद्युत धारा के विचरण को दर्शाने के लिए ग्राफ खींचिए । *3*

28. त्रिज्या r की किसी लम्बी परिनालिका में प्रति एकांक लम्बाई में फेरों की संख्या n है । इस परिनालिका में प्रवाहित धारा $I = I_0 \sin \omega t$ है । इसके केन्द्र के निकट इसके चारों ओर N फेरों की कोई कुण्डली कस कर लिपटी है ।

(क) कुण्डली में प्रेरित वि.वा. बल (emf) क्या है ?

(ख) कुण्डली और परिनालिका के बीच अन्योन्य प्रेरकत्व क्या है ? *3*

29. आइंस्टाइन का प्रकाश-विद्युत समीकरण किसी धातु के पृष्ठ से इलेक्ट्रॉन उत्सर्जन की व्याख्या किस प्रकार करता है ? संक्षेप में व्याख्या कीजिए ।

(क) आपतित विकिरणों की विभिन्न तीव्रताओं के लिए प्रकाश-विद्युत धारा का संग्राहक प्लेट विभव के साथ विचरण ग्राफ खींचकर दर्शाइए, तथा

(ख) आपतित विकिरणों की तीव्रता के साथ प्रकाश-विद्युत धारा के विचरण को दर्शाने के लिए ग्राफ खींचिए । *3*

30. (क) हाइड्रोजन परमाणु के लिए ऊर्जा स्तर आरेख खींचिए । पराबैंगनी क्षेत्र, दृश्य क्षेत्र और अवरक्त क्षेत्र की श्रेणियों के तदनुरूप संक्रमणों को अंकित कीजिए । *3*

अथवा

(ख) विभिन्न नाभिकों के लिए द्रव्यमान संख्या के साथ बंधन ऊर्जा प्रति न्यूक्लिऑन के विचरण को दर्शाने के लिए आरेख खींचिए और इसकी दो विशेषताओं का उल्लेख कीजिए । हल्के नाभिकों में प्राय: नाभिकीय संलयन क्यों होता है ? *3*

27. (a) How does the resistance differ from impedance ? With the help of a suitable phasor diagram, obtain an expression for impedance of a series LCR circuit, connected to a source $v = v_m \sin \omega t$. *3*

OR

(b) Find the condition for resonance in a series LCR circuit connected to a source $v = v_m \sin \omega t$, where ω can be varied. Give the factors on which the resonant frequency of a series LCR circuit depends. Plot a graph showing the variation of electric current with frequency in a series LCR circuit. *3*

28. A long solenoid of radius r consists of n turns per unit length. A current $I = I_0 \sin \omega t$ flows in the solenoid. A coil of N turns is wound tightly around it near its centre. What is :

(a) the induced emf in the coil ?

(b) the mutual inductance between the solenoid and the coil ? *3*

29. How does Einstein's photoelectric equation explain the emission of electrons from a metal surface ? Explain briefly.

Plot the variation of photocurrent with :

(a) collector plate potential for different intensity of incident radiation, and

(b) intensity of incident radiation. *3*

30. (a) Draw the energy level diagram for hydrogen atom. Mark the transitions corresponding to the series lying in the ultraviolet region, visible region and infrared region. *3*

OR

(b) Draw a diagram to show the variation of binding energy per nucleon with mass number for different nuclei and mention its two features. Why do lighter nuclei usually undergo nuclear fusion ? *3*

खण्ड घ

31. (क) (i) स्थिर-वैद्युतिकी में कूलॉम नियम का उल्लेख कीजिए और इसे दो आवेशों के लिए सदिश रूप में लिखिए ।

(ii) ‘गाउस नियम कूलॉम नियम में सम्मिलित दूरी के वर्ग के व्युत्क्रमानुपात पर आधारित है ।’ व्याख्या कीजिए ।

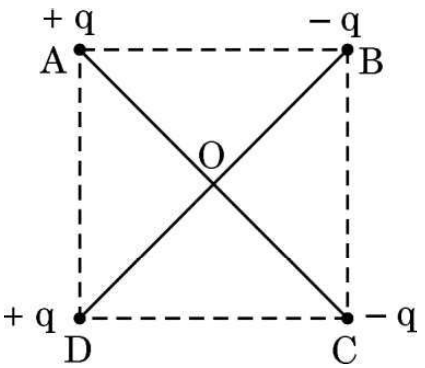
(iii) दो आवेश A (आवेश q) तथा B (आवेश 2q) क्रमश: बिन्दुओं (0, 0) और (a, a) पर स्थित हैं । मान लीजिए x-अक्ष और y-अक्ष के अनुदिश एकांक सदिश क्रमश: $\hat{i}$ और $\hat{j}$ हैं । $\hat{i}$ और $\hat{j}$ के पदों में A का B पर आरोपित बल ज्ञात कीजिए । 5

अथवा

(ख) (i) 2a दूरी के पृथकन वाले दो आवेशों q और – q के बने किसी विद्युत द्विध्रुव के निरक्षीय समतल के किसी बिन्दु पर विद्युत क्षेत्र के लिए व्यंजक व्युत्पन्न कीजिए ।

(ii) किसी विद्युत द्विध्रुव के निरक्षीय समतल पर स्थित किसी दूरस्थ बिन्दु की दूरी आधी कर दी गई है । इस द्विध्रुव के लिए विद्युत क्षेत्र किस प्रकार प्रभावित होगा ?

(iii) आरेख में दर्शाए अनुसार किसी $\sqrt{2}$ m भुजा के वर्ग ABCD के विकर्णों के अनुदिश दो सर्वसम विद्युत द्विध्रुव रखे हैं । इस वर्ग के केन्द्र (O) पर नेट विद्युत क्षेत्र का परिमाण और दिशा प्राप्त कीजिए । 5



SECTION D

31. (a) (i) State Coulomb's law in electrostatics and write it in vector form, for two charges.

(ii) 'Gauss's law is based on the inverse-square dependence on distance contained in the Coulomb's law.' Explain.

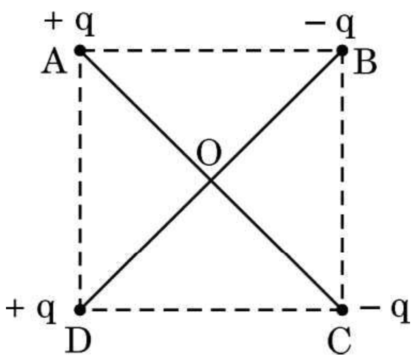
(iii) Two charges A (charge q) and B (charge 2q) are located at points (0, 0) and (a, a) respectively. Let $\hat{i}$ and $\hat{j}$ be the unit vectors along x-axis and y-axis respectively. Find the force exerted by A on B, in terms of $\hat{i}$ and $\hat{j}$. *5*

OR

(b) (i) Derive an expression for the electric field at a point on the equatorial plane of an electric dipole consisting of charges q and – q separated by a distance 2a.

(ii) The distance of a far off point on the equatorial plane of an electric dipole is halved. How will the electric field be affected for the dipole ?

(iii) Two identical electric dipoles are placed along the diagonals of a square ABCD of side $\sqrt{2}$ m as shown in the figure. Obtain the magnitude and direction of the net electric field at the centre (O) of the square. *5*



32. (क) (i) किसी धारावाही अवयव के कारण चुम्बकीय क्षेत्र के लिए बायो-सावर्ट नियम लिखिए । इस नियम का उपयोग करके त्रिज्या ‘a’ के किसी वृत्ताकार पाश, जिससे धारा ‘I’ प्रवाहित हो रही है, के केन्द्र पर चुम्बकीय क्षेत्र के लिए कोई व्यंजक प्राप्त कीजिए । किसी धारा पाश के लिए चुम्बकीय क्षेत्र की दिशा को इंगित करते हुए चुम्बकीय क्षेत्र रेखाएँ खींचिए ।

(ii) कोई इलेक्ट्रॉन किसी नाभिक की वृत्ताकार कक्षा में 10^7 m s^{-1} की चाल से परिक्रमा कर रहा है । यदि कक्षा की त्रिज्या 10^{-10} m है, तो कक्षा में परिक्रमा करने वाले इलेक्ट्रॉन द्वारा उत्पन्न धारा ज्ञात कीजिए । 5

अथवा

(ख) (i) चुम्बकीय क्षेत्र में स्थित किसी धारावाही सीधे चालक पर कार्यरत बल के लिए व्यंजक व्युत्पन्न कीजिए । उस नियम का उल्लेख कीजिए जो इस बल की दिशा को निर्धारित करने के लिए उपयोग किया जाता है । वह शर्त दीजिए जिसके अंतर्गत यह बल (1) अधिकतम, और (2) निम्नतम होता है ।

(ii) दो लम्बे सीधे समान्तर तार A और B वायु में एक-दूसरे से 2·5 cm दूरी पर हैं । इन तारों से विपरीत दिशाओं में क्रमश: 5·0 A और 2·5 A धाराएँ प्रवाहित हो रही हैं । तार B की 10 cm लम्बाई पर तार A द्वारा आरोपित बल का परिमाण परिकलित कीजिए । 5

33. (क) (i) (1) व्यतिकरण पैटर्न और विवर्तन पैटर्न के बीच दो अन्तर लिखिए ।

(2) यंग के द्विझिरी प्रयोग में किन्हीं दो कारकों के नाम लिखिए जिन पर फ्रिंज चौड़ाई निर्भर करती है ।

32. (a) (i) State Biot-Savart's law for the magnetic field due to a current carrying element. Use this law to obtain an expression for the magnetic field at the centre of a circular loop of radius 'a' and carrying a current 'I'. Draw the magnetic field lines for a current loop indicating the direction of magnetic field.

(ii) An electron is revolving around the nucleus in a circular orbit with a speed of 10^7 m s^{-1}. If the radius of the orbit is 10^{-10} m, find the current constituted by the revolving electron in the orbit. *5*

OR

(b) (i) Derive an expression for the force acting on a current carrying straight conductor kept in a magnetic field. State the rule which is used to find the direction of this force. Give the condition under which this force is (1) maximum, and (2) minimum.

(ii) Two long parallel straight wires A and B are 2·5 cm apart in air. They carry 5·0 A and 2·5 A currents respectively in opposite directions. Calculate the magnitude of the force exerted by wire A on a 10 cm length of wire B. *5*

33. (a) (i) (1) Write two points of difference between an interference pattern and a diffraction pattern.

(2) Name any two factors on which the fringe width in a Young's double-slit experiment depends.

(ii) यंग के किसी द्विझिरी प्रयोग में दो झिरियों के बीच पृथकन झिरियों से गुज़रने वाले प्रकाश की तरंगदैर्ध्य का 100 गुना है ।

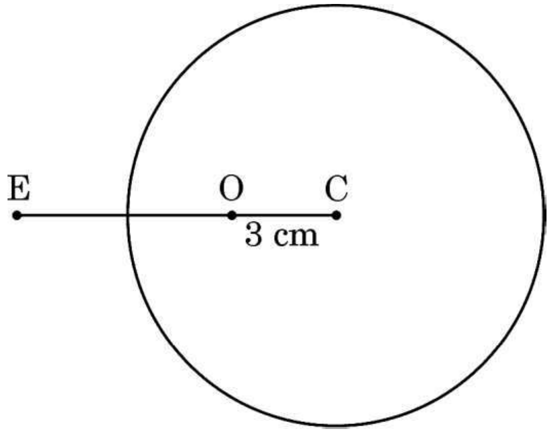
(1) केन्द्रीय उच्चिष्ठ और निकटवर्ती उच्चिष्ठ के बीच कोणीय पृथकन का रेडियनों में परिकलन कीजिए ।

(2) झिरियों से 50 cm दूरी पर स्थित पर्दे पर इन दोनों उच्चिष्ठों के मध्य दूरी परिकलित कीजिए । *5*

अथवा

(ख) (i) वक्रता त्रिज्या R का कोई गोलीय पृष्ठ n_1 और n_2 अपवर्तनांकों के दो माध्यमों को एक-दूसरे से पृथक करता है । n_1 अपवर्तनांक के माध्यम में कोई बिन्दुकित बिम्ब इस पृष्ठ से दूरी u पर रखा है और पृष्ठ द्वारा इसका प्रतिबिम्ब n_2 अपवर्तनांक के माध्यम में पृष्ठ से v दूरी पर बन रहा है । u और v के बीच संबंध व्युत्पन्न कीजिए ।

(ii) आरेख में दर्शाए अनुसार 6·0 cm त्रिज्या के किसी ठोस काँच के गोले में गोले के केन्द्र C से 3·0 cm दूरी पर कोई छोटा वायु का बुलबुला फंसा हुआ है । गोले के पदार्थ का अपवर्तनांक 1·5 है । वायु में किसी बाहरी बिन्दु E से गोले की सतह में से देखने पर इस बुलबुले की आभासी स्थिति ज्ञात कीजिए । *5*



(ii) In Young's double-slit experiment, the two slits are separated by a distance equal to 100 times the wavelength of light that passes through the slits. Calculate :

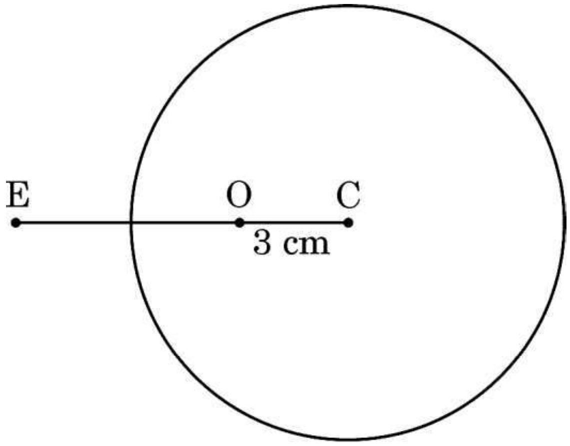
(1) the angular separation in radians between the central maximum and the adjacent maximum.

(2) the distance between these two maxima on a screen 50 cm from the slits. *5*

OR

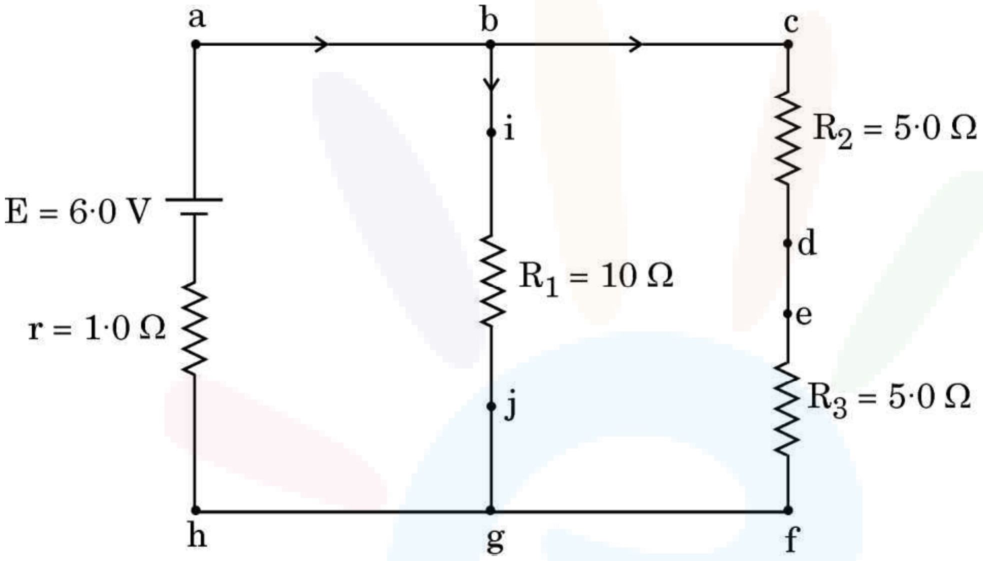
(b) (i) A spherical surface of radius of curvature R separates two media of refractive indices n_1 and n_2. A point object is placed in front of the surface at distance u in medium of refractive index n_1 and its image is formed by the surface at distance v, in the medium of refractive index n_2. Derive a relation between u and v.

(ii) A solid glass sphere of radius 6·0 cm has a small air bubble trapped at a distance 3·0 cm from its centre C as shown in the figure. The refractive index of the material of the sphere is 1·5. Find the apparent position of this bubble when seen through the surface of the sphere from an outside point E in air. *5*



खण्ड ङ

34. निम्नलिखित चित्र एक विद्युत परिपथ आरेख को दर्शाता है । हम किरखोफ नियमों का उपयोग करके विभिन्न प्रतिरोधकों में धारा और उनके सिरों पर विभवान्तर ज्ञात कर सकते हैं ।



उपर्युक्त के आधार पर निम्नलिखित प्रश्नों के उत्तर दीजिए :

(क) इस परिपथ में कौन-से बिन्दु समान विभव पर हैं ? *1*

(ख) भुजा bg में धारा कितनी है ? *1*

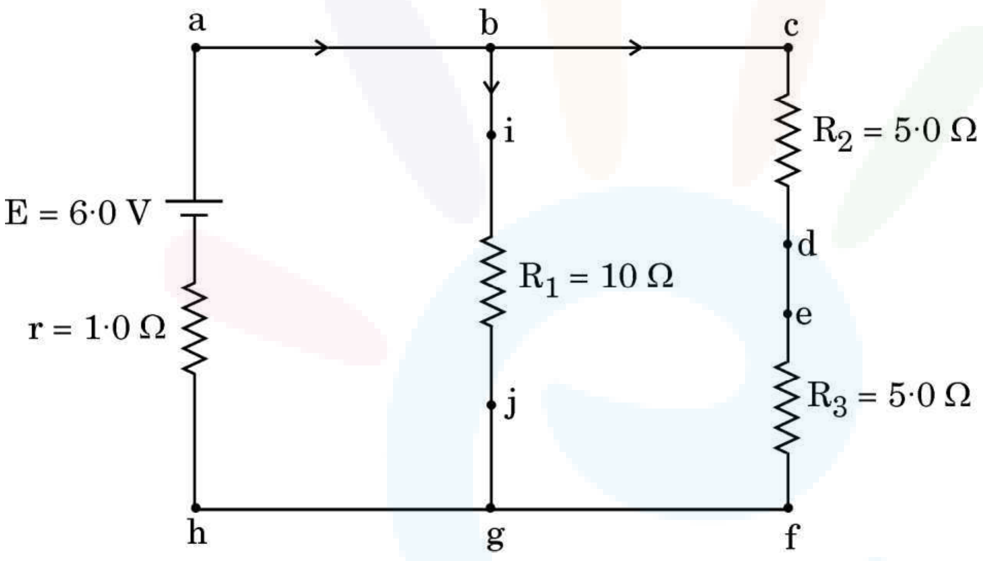
(ग) प्रतिरोध R_3 के सिरों पर कितना विभवान्तर है ? *2*

अथवा

(ग) प्रतिरोध R_2 में शक्ति क्षय कितना है ? *2*

SECTION E

34. The following figure shows a circuit diagram. We can find the currents through and potential differences across different resistors using Kirchhoff's rules.



Answer the following questions based on the above :

(a) Which points are at the same potential in the circuit ? *1*

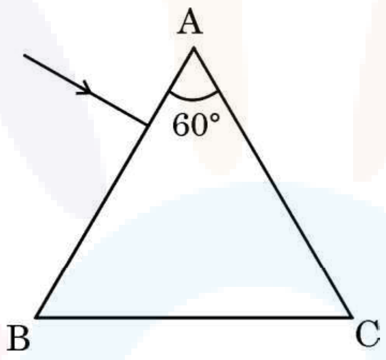
(b) What is the current through arm bg ? *1*

(c) Find the potential difference across resistance R_3. *2*

OR

(c) What is the power dissipated in resistance R_2 ? *2*

35. स्ट्रॉन्शियम टाइटैनेट एक दुर्लभ ऑक्साइड है जो साइबेरिया में पाया जाने वाला प्राकृतिक खनिज है । इसका उपयोग हीरे के विकल्प के रूप में किया जाता है क्योंकि इसका अपवर्तनांक और क्रांतिक कोण क्रमश: 2·41 और 24·5° हैं जो कि हीरे के अपवर्तनांक और क्रांतिक कोण के लगभग बराबर हैं । इसमें हीरे के सभी गुण होते हैं । यहाँ तक कि कोई प्रवीण जौहरी भी हीरे और स्ट्रॉन्शियम टाइटैनेट के बीच विभेदन नहीं कर पाता है । स्ट्रॉन्शियम टाइटैनेट से बने किसी समबाहु त्रिभुजाकर प्रिज़्म ABC के एक फलक पर कोई प्रकाश किरण अभिलम्बवत आपतन कर रही है ।



उपर्युक्त के आधार पर निम्नलिखित प्रश्नों के उत्तर दीजिए :

(क) इस प्रकाश किरण का इस प्रिज़्म से गुजरते हुए पथ आरेखित कीजिए । *1*

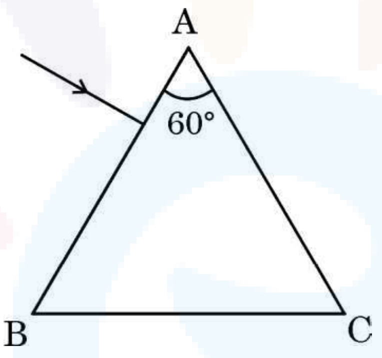
(ख) प्रिज़्म में प्रकाश का वेग ज्ञात कीजिए । *1*

(ग) पूर्ण आन्तरिक परावर्तन के दो अनुप्रयोगों की संक्षेप में व्याख्या कीजिए । *2*

अथवा

(ग) प्रकाश के पूर्ण आन्तरिक परावर्तन की परिभाषा लिखिए । इसके होने के लिए दो शर्तें बताइए । *2*

35. Strontium titanate is a rare oxide — a natural mineral found in Siberia. It is used as a substitute for diamond because its refractive index and critical angle are 2·41 and 24·5°, respectively, which are approximately equal to the refractive index and critical angle of diamond. It has all the properties of diamond. Even an expert jeweller is unable to differentiate between diamond and strontium titanate. A ray of light is incident normally on one face of an equilateral triangular prism ABC made of strontium titanate.



Answer the following questions based on the above :

(a) Trace the path of the ray showing its passage through the prism. *1*

(b) Find the velocity of light through the prism. *1*

(c) Briefly explain two applications of total internal reflection. *2*

OR

(c) Define total internal reflection of light. Give two conditions for it. *2*

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2023
SUBJECT: PHYSICS (042) (PAPER CODE 55/1/1)

General Instructions : -

1 You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.

2 **"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**

3 Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**

4 The Marking scheme carries only suggested value points for the answers

These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.

5 The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.

6 Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓)while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**

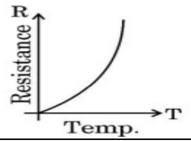
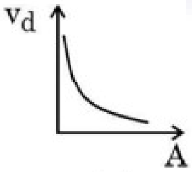
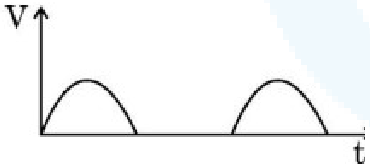
7 If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.

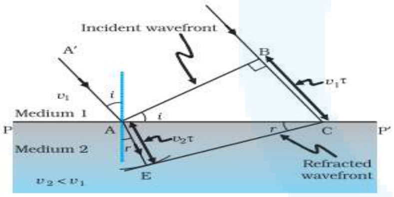
8 If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.

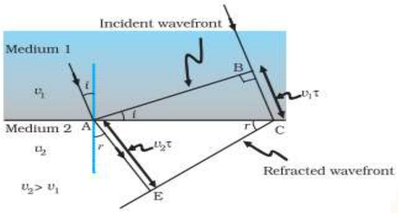
9	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0 - 70(example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any un assessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

MARKING SCHEME: PHYSICS(042)

Code: 55/1/1

Q.No.	VALUE POINTS/EXPECTED ANSWERS	Marks	Total Marks
	SECTION –A		
1.	(b) $\frac{\overrightarrow{F}}{8}$	1	1
2.	(d)  	1	1
3.	(d) 1 Ω	1	1
4.	(a)  	1	1
5.	(a) Repelled by both the poles.	1	1
6.	(c) 0.19 V	1	1
7.	(c) Resistance (r)	1	1
8.	(c) $\in_o \frac{d\phi_E}{dt}$	1	1
9.	(a) Zero	1	1
10.	(c) n^2	1	1
11.	(d) 95 nm	1	1
12.	(d) Independent of A	1	1
13.	(c)  	1	1
14.	(b) it becomes a p-type semiconductor	1	1
15.	(d) 0.01 eV	1	1
16.	(d) Assertion (A) is false and Reason (R) is also false.	1	1
17.	(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).	1	1
18.	(b) Both Assertion (A) and Reason (R) are true but reason (R) is the **not** correct explanation of the Assertion (A)	1	1
	SECTION-B		

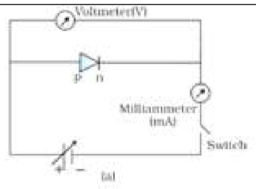
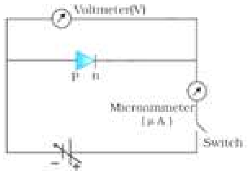
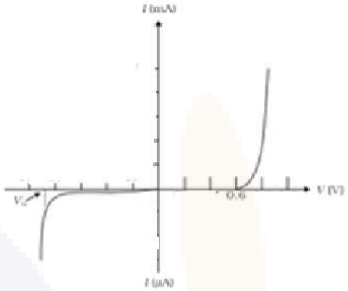
19.	Calculation of acceleration of alpha particle 2 $\vec{F}=q(\vec{v}\times\vec{B})$ $= q(3\times10^5\hat{i}\times(0.4\hat{i}+0.3\hat{j}))N$ $\vec{F} = q(0.9\times10^5\hat{k})N$ $\vec{F} = m\vec{a} = q(0.9\times10^5\widehat{k})N$ $\vec{a} = \frac{q}{m}(0.9\times10^5\hat{k})ms^{-2}$ $= 4.8\times10^7\times0.9\times10^5\ \hat{k}\ ms^{-2}$ $= 4.32\times10^{12}\ \hat{k}\ ms^{-2}$ Note: Deduct ½ mark if a student does not mention the direction of acceleration.	½ ½ ½ ½	2
20.	Identification 1 Justification 1 Induced electric field due to changing magnetic field is easily observed. Induced electric field due to changing magnetic field can be easily produced by various ways like rotating/moving a coil in magnetic field, changing the shape of coil in magnetic field, bringing bar magnet near a coil etc.	1 1	2
21.	(a) Ray diagram 1 Proof of Snell's law of refraction 1  AB is incident wave front, incident at an angle i. Let τ be time taken by the wave front to travel distance BC. BC= $v_1\ \tau$ where v_1 is speed of wave in medium 1. To determine shape of refracted wave front, we draw a sphere of radius $v_2\ \tau$, where v_2 is speed of wave in medium 2. CE represents a tangent drawn from point C on sphere, CE is the refracted wave front. $\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$ $\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$	1 ½	

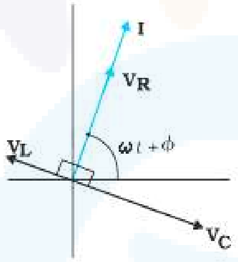
	$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = n_{21}$ **Note:** Give full credit if student derives Snell's law by taking incident wavefront in denser medium.  OR (b) Reason for preferring reflecting type telescope over refracting telescope ½ + ½ Justification ½ + ½ 1 No Chromatic Aberration - No refraction in mirrors 2 No Spherical Aberration - Due to use of parabolic reflector 3 Easy mechanical support required - Mirrors weigh less and can be supported over entire back surface. 4 High resolving power – Due to Mirror with large diameter. 5 Brighter image – Large mirrors gather more light waves. **(Any two)**	½ 1+1	2
22.	Finding the ratio of maximum and minimum intensities 2 $\frac{I_{\max}}{I_{\min}} = \frac{(\sqrt{I_1}+\sqrt{I_2})^2}{(\sqrt{I_1}-\sqrt{I_2})^2}$ $= \frac{I_1+I_2+2\sqrt{I_1 I_2}}{I_1+I_2-2\sqrt{I_1 I_2}}$ $= \frac{5I+4I}{5I-4I}$ $= \frac{9}{1}$ **Alternatively** $\frac{I_1}{I_2} = \frac{a^2}{b^2} = \frac{4I}{I} = \frac{4}{1}$ $\frac{a}{b} = \frac{2}{1}$	½ ½ ½ ½ ½ ½	

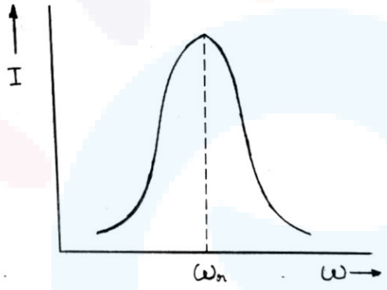
<table>
<tr>
<td></td>
<td>$\frac{I_{\max}}{I_{\min}}=\frac{(a+b)^2}{(a-b)^2}$
$\frac{I_{\max}}{I_{\min}}=\frac{(2+1)^2}{(2-1)^2}=\frac{9}{1}$</td>
<td>½
½</td>
<td>2</td>
</tr>
<tr>
<td>23.</td>
<td>Calculation of potential energy of electron 1
Calculation of kinetic energy of electron 1

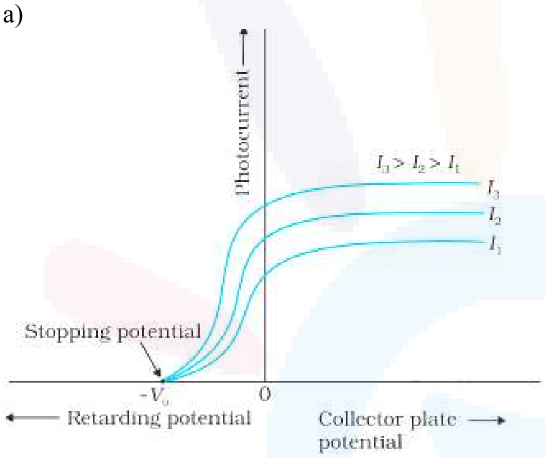
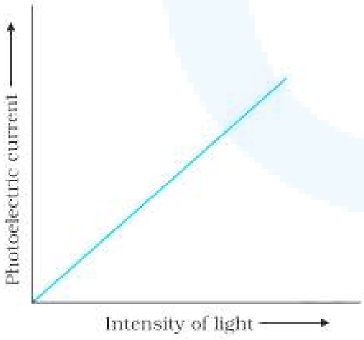
$E_n = \frac{-13.6}{n^2}eV$ = Total energy
For third excited state n=4
$E_4 = \frac{-13.6}{4^2} = \frac{-13.6}{16}$ = -0.85 eV
Potential Energy = 2 × Total Energy = 2 × E_4
= 2 ×(-0.85) eV
= - 1.70 eV

Kinetic energy = - (Total Energy) = $-E_4$
= 0.85 eV</td>
<td>½
½
½
½</td>
<td>2</td>
</tr>
<tr>
<td>24.</td>
<td>(a)
Difference between intrinsic and extrinsic semiconductor 2
<table>
<tr><th>Intrinsic semiconductor</th><th>Extrinsic semiconductor</th></tr>
<tr><td>1. Pure semiconductor.</td><td>Semiconductor is Doped with impurities.</td></tr>
<tr><td>2. Low conductivity at room temperature.</td><td>High conductivity at room temperature.</td></tr>
<tr><td>3. $n_e = n_h$</td><td>$n_e \neq n_h$</td></tr>
</table>
(Any one)
Note: Give full credit if a student writes any other relevant correct answer.
OR
(b)
Circuit diagram for forward and reverse biased p-n junction diode ½ + ½
V-I characteristic (Forward and Reverse bias) ½ + ½</td>
<td>1+1</td>
<td></td>
</tr>
</table>

	 Forward Bias  Reverse Bias  Characteristics of silicon Diode	½ + ½ ½ + ½	2
25.	Formation of potential barrier 2 The diffusion current due to concentration gradient at the junction forms a space charge region consisting of immobile charge carriers. Due to this an electric field is generated at the junction giving rise to drift current in a direction opposite to diffusion current. The potential at which diffusion current becomes equal to drift current is called potential barrier.	2	2
	SECTION –C		
26.	a) Finding electric potential at the centre 1 Finding electric field at the centre 1 b) Finding electric potential at the centre 1 (a) Electric potential due to point charge $V= \frac{kq}{R}$ Value of each charge = - q , Total charge = -12q Total potential $V = \frac{k(-12q)}{R}$ $V = \frac{-12kq}{R} = \frac{-12q}{4\pi \in_0 R}$ By symmetry the resultant of all electric field vectors becomes zero. So electric field is zero.	½ ½ 1	

	(b) Electric potential is a scalar quantity and does not depend on placement of charges Therefore V= $\frac{-12kq}{R} = \frac{-12q}{4\pi \in_0 R}$	1	3
27.	(a) Difference between resistance and impedance 1 Obtaining expression for impedance 2 1. Resistance is the opposition offered to both alternating current and direct current while impedance is the opposition offered to alternating current only. 2. Resistance is independent of frequency of source while impedance depends on frequency. 3. Resistance is opposition offered by material of the conductor while impedance is combined opposition offered by different electrical components such as resistor, inductor or capacitor. **(Any One)** (Note: Give credit of this part if a student writes any other correct answer.)	1	
		½	
	$V_R = i_mR$, $V_c = i_m X_c$, $V_L = i_mX_L$ i_m = Peak value of current in the circuit. $\vec{V_L} + \vec{V_R} + \vec{V_C} = \vec{V_m}$	½	
	$(V_m)^2 = V_R^2 + (V_C – V_L)^2$ $= (i_mR)^2 + (i_mX_c - i_mX_L)^2$ $= i_m [R^2 + (X_c – X_L)^2]$	½	
	$i_m = \frac{V_m}{\sqrt{R^2 + (X_c - X_L)^2}}$ $i_m = \frac{V_m}{Z}$ where $Z = \sqrt{R^2 + (X_c - X_L)^2}$ = impedance	½	

	OR		
	(b)		
	Finding condition for resonance 1 Factors affecting resonant frequency 1 Graph 1		
	$Z = \sqrt{R^2+(X_L-X_c)^2}$	½	
	For maximum current, Z should be minimum therefore to minimize Z $X_L = X_C$	½	
	Alternatively		
	$X_L = X_C$	½	
	$\omega L = \frac{1}{\omega C}$		
	$\omega_r = \frac{1}{\sqrt{LC}}$	½	
	Resonant Frequency depends on value of Inductance and Capacitance	½ + ½	
		1	3
28.	Finding a) Induced emf 2 b) Mutual inductance between solenoid and coil 1		
	a) magnetic field produced in the solenoid near the center $B = \mu_o nI$	½	
	Flux linked with the coil wound over solenoid $\phi = NBA = N\pi r^2 B$ $= N\pi r^2 \mu_o nI$	½	
	Induced emf $e = \frac{-d\phi}{dt} = -\pi r^2 Nn\mu_o \frac{dI}{dt}$ (i)	½	
	$= - \mu_o\pi r^2 nN I_o\omega \cos \omega t$	½	

	b) comparing Eq (i) with $e = -M\frac{dI}{dt}$ M = $\mu_o\pi r^2 nN$	½ ½	3
29.	Explanation of emission of electron 1 a) variation of photocurrent with collector plate potential for different intensity 1 b) variation of photo current with intensity of incident radiation 1 According to Einstein's photoelectric equation An electron absorbs a quantum of energy 'hυ' of incident radiation. If the energy of absorbed quantum exceeds the minimum energy needed by the electron to escape from the metal surface (work function φ_o), the electron is emitted. $K_{max} = h\upsilon - \varphi_o$ a)  b)  	1 1 1	3

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<tr>
<td>30.</td>
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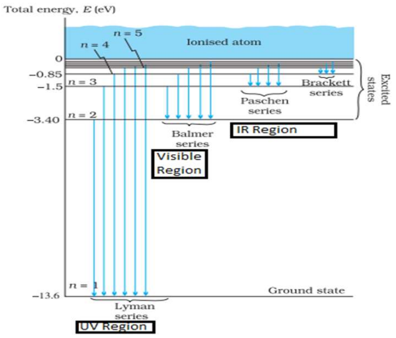
a)

Energy level diagram for hydrogen atom 1 ½
Transitions corresponding to ultraviolet region, visible region and infrared region ½ + ½ + ½

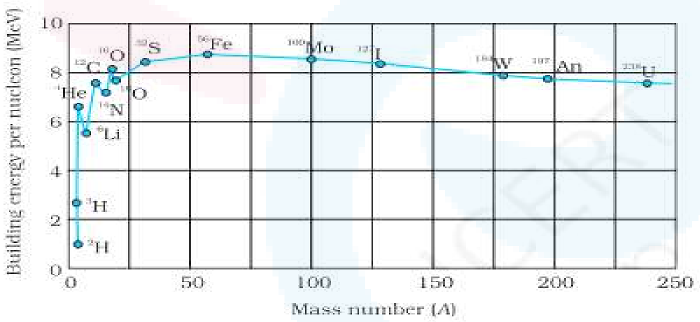


Note: Award 1 ½ mark for energy level diagram if the student does not show the transitions.

OR

b)

Diagram to show variation 1
Two features of diagram ½ + ½
Reason for nuclear fusion 1

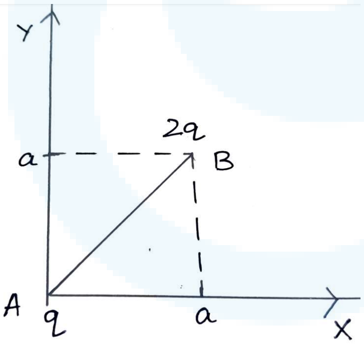


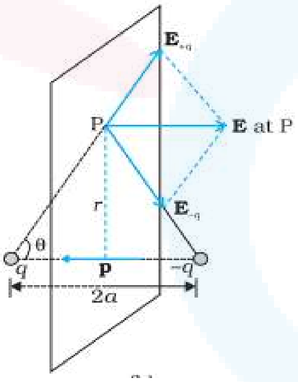
(Note: Award full credit even if a student does not mark so many elements and does not mention the values of E_{bn}.)

Features of diagram **(any two)**
1. Binding energy per nucleon is practically independent of atomic number for nuclei of middle mass number (30 <A < 170)
2. The curve has maximum of about 8.75 MeV for A= 56 and has a value of 7.6 MeV for A= 238
3. Binding energy per nucleon is lower for both light nuclei (A<30) and heavy nuclei (A>170)

Two lighter nuclei fuse together to form heavier nuclei as the binding energy per nucleon of fused heavier nuclei is more than the binding energy per nucleon of the lighter nuclei. Thus the final system is more tightly bound

</td>
<td>1 ½
½
½
½
1
½ + ½</td>
<td></td>
</tr>
</table>

	than initial system. **Alternatively** To attain the stability	1	3
	SECTION –D		
31.	(a) i) Statement of coulomb's law and vector form 1+1 ii) Explanation of Gauss's law based on coulomb's law 1 iii) Force exerted by charge A on charge B 2		
	i) Force between two point charges varies inversely with the square of distance between the charges and is directly proportional to the product of magnitude of the two charges and acts along the line joining the two charges.	1	
	$\overrightarrow{F_{12}} = \frac{1}{4\pi \epsilon_o}\frac{q_1q_2}{r_{12}^2}\widehat{r_{12}}$	1	
	Alternatively $\overrightarrow{F_{12}} = \frac{1}{4\pi \epsilon_o}\frac{q_1q_2}{r_{12}^3}\overrightarrow{r_{12}}$ Where $\overrightarrow{r_{12}}$ is a vector from charge q_2 to charge q_1.		
	ii) In derivation of Gauss's law, flux is calculated using Coulomb's law and surface area. Here coulomb's law involves $\frac{1}{r^2}$ factor and surface area involves r^2 factor. When product is taken, the two factors cancel out and flux becomes independent of r.	1	
	iii) 	½	
	$\vec{r} = \overrightarrow{AB} = a\hat{i} + a\hat{j}$ r = $\left\|\overrightarrow{AB}\right\| = \sqrt{a^2 + a^2} = \sqrt{2}a$	½	
	$\vec{F} = \frac{1}{4\pi \epsilon_o}\frac{q_1q_2}{r^2}\hat{r}$		

	$\vec{F}=\frac{1}{4\pi\in_o}\times\frac{q\times 2q}{(\sqrt{2}a)^2}\times\frac{(a\hat{i}+a\hat{j})}{\sqrt{2}a}$	½	
	$\vec{F}=\frac{1}{4\pi\in_o}\times\frac{2q^2}{2a^2}\times\frac{(\hat{i}+\hat{j})}{\sqrt{2}}$		
	$\vec{F}=\frac{1}{4\pi\in_o}\times\frac{q^2}{\sqrt{2}a^2}\times(\hat{i}+\hat{j})$		
	$\vec{F}=\frac{q^2}{4\sqrt{2}\pi\in_o a^2}(\hat{i}+\hat{j})$	½	
	Note: Award 1 mark if a student calculates the magnitude of force only. $\lvert\vec{F}\rvert=\frac{1}{4\pi\in_o}\frac{q^2}{a^2}$		
	Alternatively Give full credit if a student uses component method to solve the question. OR (b)		
	i) Derivation of electric field — 2 ii) Effect on electric field — 1 iii) Finding magnitude and direction of electric field — 2		
	i) 	½	
	$E_{+q}=\frac{q}{4\pi\in_o}\times\frac{1}{r^2+a^2}$		
	$E_{-q}=\frac{q}{4\pi\in_o}\times\frac{1}{r^2+a^2}$		
	The components normal to dipole axis cancel away. The components along the dipole axis add up.	½	
	Total electric field is opposite to dipole moment.	½	
	$\vec{E}=-(E_{+q}+E_{-q})\cos\theta\hat{p}$ $=\frac{-2qa}{4\pi\in_o(r^2+a^2)^{3/2}}\hat{p}$		

$$= \frac{-\vec{p}}{4\pi \in_o (r^2+a^2)^{3/2}}$$ ½

Deduct ½ mark if the expression of electric field is not in vector form.

ii) At far off point r >> a

$$\vec{E} = \frac{-\vec{p}}{4\pi \in_o r^3}$$

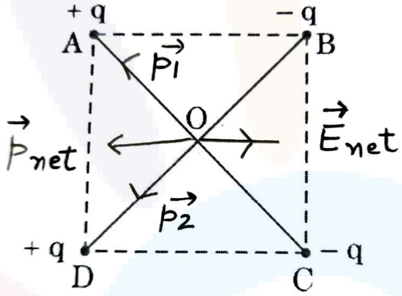
When distance is halved.

$$\vec{E} = \frac{-\vec{p}}{4\pi \in_o (\frac{r}{2})^3}$$ ½

$$= \frac{-8\vec{p}}{4\pi \in_o r^3}$$ ½

$\vec{E}$ becomes 8 times

iii)



$p_1 = q \times 2Cm$ (along OA)

$p_2 = q \times 2Cm$ (along OD)

$$p_{net} = \sqrt{p_1^{\,2} + p_2^{\,2}}$$ ½

$$= 2\sqrt{2}\, q\, Cm$$

Electric field at centre O

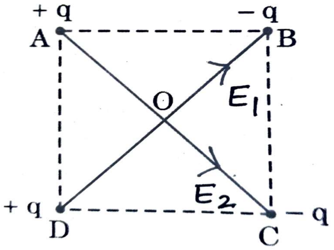
$$E = \frac{kp_{net}}{(r^2+a^2)^{3/2}}$$ ½

at point O, r = 0 , a = 1 m

$$E = \frac{k \times 2\sqrt{2}q}{1^3} = 2\sqrt{2}kq = \frac{2\sqrt{2}q}{4\pi \in_o}$$ ½

Along DC ½

Alternatively



$E = \frac{kq}{r^2}$ ½

AC= BD= 2m

r = OA =OB= OC=OD=1m

Electric field at O due to charges at B and D

$E_1 = E_B + E_D$

$E_1 = \frac{kq}{1^2} + \frac{kq}{1^2}$ along OB

$= 2kq$ ½

Electric field at O due to charges at A and C

$E_2 = E_A + E_C$

$E_2 = \frac{kq}{1^2} + \frac{kq}{1^2}$ ½

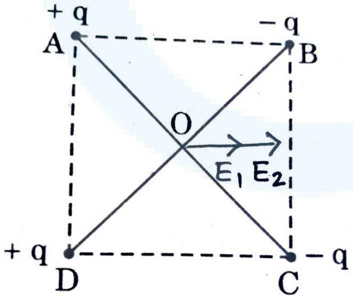
$= 2kq$ along OC

$E_{net} = \sqrt{E_1^2 + E_2^2}$

$= 2\sqrt{2}\,kq = \frac{2\sqrt{2}q}{4\pi \in_o}$ ½

Along DC

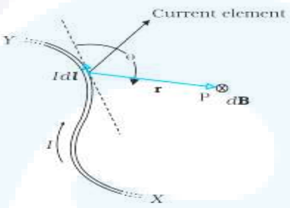
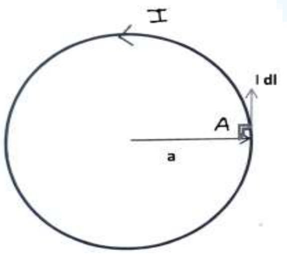
Alternatively



Considering AB as dipole, electric field at O

$E_1 = \frac{2kq \times a}{((\frac{1}{\sqrt{2}})^2 + (\frac{1}{\sqrt{2}})^2)^{3/2}} = \frac{2kqa}{(\frac{1}{2}+\frac{1}{2})^{3/2}} = 2kqa$ ½

Similarly considering DC as another dipole, electric field at O

<table>
<tr><td></td><td>$E_2 = \frac{2kq \times a}{((\frac{1}{\sqrt{2}})^2 + (\frac{1}{\sqrt{2}})^2)^{3/2}} = \frac{2kqa}{(\frac{1}{2} + \frac{1}{2})^{3/2}} = 2kqa$</td><td>½</td><td></td></tr>
<tr><td></td><td>$E_{net} = E_1 + E_2 = 4kqa = \frac{1}{4\pi \in_o} \times 4 \times \frac{1}{\sqrt{2}} \times q$</td><td>½</td><td></td></tr>
<tr><td></td><td>$= 2\sqrt{2}kq = \frac{2\sqrt{2}q}{4\pi \in_o}$</td><td>½</td><td></td></tr>
<tr><td></td><td>Along DC</td><td></td><td>5</td></tr>
<tr><td>32.</td><td>(a)
<table>
<tr><td>i) Statement of Biot-Savart's law</td><td>1</td></tr>
<tr><td>Expression for magnetic field</td><td>2</td></tr>
<tr><td>Diagram for magnetic field lines</td><td>½</td></tr>
<tr><td>ii) Finding current by revolving electron</td><td>1 ½</td></tr>
</table></td><td></td><td></td></tr>
<tr><td></td><td>(i)
The magnetic field at a point due to a current carrying element is proportional to magnitude of current, element length and inversely proportional to the square of the distance from the element.</td><td>1</td><td></td></tr>
<tr><td></td><td>$\vec{dB} = \frac{\mu_o}{4\pi} I \frac{\vec{dl} \times \vec{r}}{r^3}$
$|dB| = \frac{\mu_o}{4\pi} \frac{Idl \sin\theta}{r^2}$
 </td><td></td><td></td></tr>
<tr><td></td><td>Consider a circular coil of radius a carrying current I.
 </td><td>½</td><td></td></tr>
<tr><td></td><td>According to Biot-Savart's law
$|\vec{dB}| = \frac{\mu_o}{4\pi} \frac{Idl \sin\theta}{r^2}$</td><td>½</td><td></td></tr>
<tr><td></td><td>At point A I $\vec{dl} \perp \vec{a}$</td><td></td><td></td></tr>
</table>

$\therefore \theta = 90^o, \sin 90^o = 1$

Hence dB= $\frac{\mu_o}{4\pi}\frac{Idl}{a^2}$

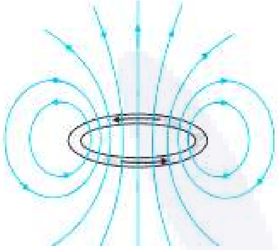
Magnetic field at centre

B= $\int_o^{2\pi a} dB = \int_0^{2\pi a} \frac{\mu_o}{4\pi}\frac{Idl}{a^2}$ ½

B= $\frac{\mu_o}{4\pi} \times \frac{I}{a^2} \times 2\pi a$ ½

B = $\frac{\mu_o I}{2a}$

Note: Give full credit of 2 marks if a student derives the expression for magnetic field at the axis of the loop and then puts the distance of point as 0 from the centre.

 ½

ii) q=e , v=10^7ms^{-1},r=10^{-10}m

i= $\frac{q}{T}$ ½

= $\frac{qv}{2\pi r}$

= $\frac{ev}{2\pi r}$ ½

= $\frac{1.6\times10^{-19}\times10^7}{2\times\pi\times10^{-10}}$

= $\frac{0.8}{\pi}\times10^{-2} A$ ½

= $0.255 \times10^{-2} A$ = 2.55 mA

OR

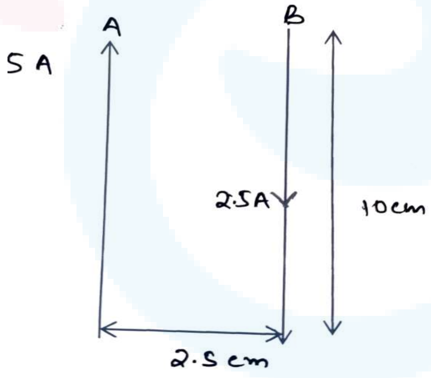
b)

i) Derivation of expression for force	2
Statement of Rule	½
Conditions for maximum and minimum force	½ + ½
ii) Calculation of magnitude of force	1 ½

Consider a rod of uniform cross sectional area A and length l. Let the number density of mobile charge carriers in it be n.

Thus the total number of mobile charge carriers in it is n l A.

For steady current I, drift velocity of electrons $\overrightarrow{v_d}$, in the presence of ½

	external magnetic field $\vec{B}$, the force on these carriers is		
	$\vec{F} = n\,l\,Aq(\vec{v_d} \times \vec{B})$	½	
	$= \left[\vec{j}Al\right] \times \vec{B}$	½	
	$= I(\vec{l} \times \vec{B})$	½	
	Where $nq\vec{v_d}$ is current density ($\vec{j}$) and $\left\|\vec{j}A\right\|$ is current (I)		
	Fleming's left hand Rule: If forefinger, middle finger and thumb are stretched in mutually perpendicular directions, such that forefinger indicates the direction of magnetic field, middle finger indicates the direction of current in the conductor, then thumb indicates the direction of force on the conductor.		
	Alternatively		
	Right Hand Thumb Rule : If the fingers of right hand are made to rotate from $\vec{l}$ to $\vec{B}$ through angle θ, the thumb points in the direction of force on the current carrying conductor.	½	
	Condition for maximum force $\theta = 90^0$		
	$\left\|\vec{F}\right\| = I\,l\,B\sin\theta$ = I l B	½	
	Condition for minimum force $\theta = 0^o$ or 180^0		
	$\left\|\vec{F}\right\| = 0$	½	
	ii) 		
	F= $\frac{\mu_o}{4\pi}\frac{2I_1I_2}{d}\,l$	½	
	$= \frac{10^{-7} \times 2 \times 5 \times 2.5}{2.5 \times 10^{-2}} \times 10 \times 10^{-2}\,N$	½	
	$= 10^{-5}$ N	½	5

33. a)

i) (1) Difference between interference pattern and diffraction pattern	1+1
(2) Two factors affecting fringe width in young's double slit experiment	½ + ½
ii) (1) calculation of angular separation	1
(2) calculation of distance between two maxima	1

(i) (1)

(a) The interference pattern has a number of equally spaced bright and dark bands while diffraction pattern has a central bright maximum which is twice as wide as the other maxima.

(b) Interference pattern is obtained by superposing two waves originating from two narrow slits, while diffraction pattern is a superposition of a continuous family of waves originating from each point on a single slit.

(c) The maxima in interference pattern is obtained at angle λ / a, while the first minima is obtained at same angle λ / a for diffraction pattern.

(d) In interference pattern the intensity of bright fringes remain same while in diffraction the intensity falls as we go to successive maxima away from the center on either side. 1+1

(any two)

(2) Factors affecting fringes width

Wave length (λ) / distance of screen from slits (D) / separation between slits (d). ½ + ½

(any two)

(ii) (1) $d \sin\theta = n\lambda$ ½

$n=1$

$$\sin\theta = \frac{\lambda}{d}$$

For small angle $\sin\theta \approx \theta = \frac{\lambda}{100\lambda} = \frac{1}{100}$ radian. ½

(2) $\beta = \frac{\lambda D}{d} = \theta D$ ½

$$= \frac{1}{100} \times 50\times10^{-2}$$

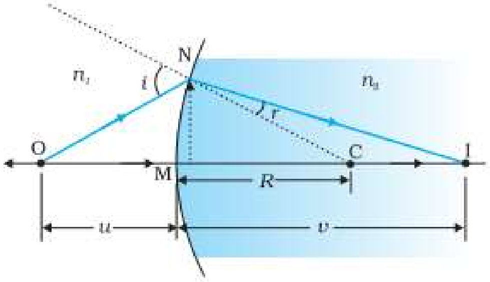
$$= 50 \times 10^{-4} m$$

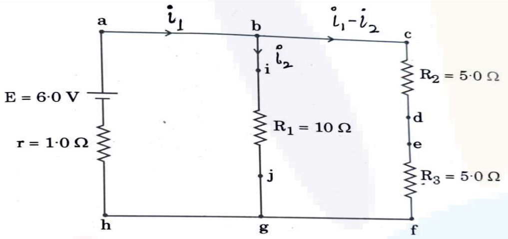
= 5 mm ½

OR

(b)

i) Derivation of relation between u and v	3
ii) Finding apparent position	2

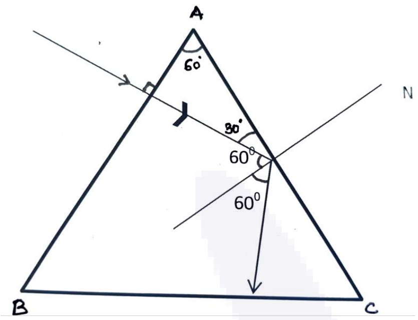
		1	
	Assume that the aperture of the surface is small as compared to other distance involved, so that small angle approximation can be made. For small angles for ΔNOC, i is the exterior angle $\therefore$ i = $\angle NOM + \angle NCM$ i= $\frac{MN}{OM}+\frac{MN}{MC}$ (i)	½	
	Similarly r = $\angle NCM - \angle NIM$ $=\frac{MN}{MC}-\frac{MN}{MI}$ (ii) By Snell's law $n_1 \sin i = n_2 \sin r$ for small angles n_1 i = n_2 r	½	
	substituting i and r from (i) and (ii) we get $\frac{n_1}{OM}+\frac{n_2}{MI}=\frac{n_2-n_1}{MC}$	½	
	Applying Cartesian coordinates OM= -u, MI= + v , MC= +R $\frac{n_2}{v}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$	½	
	(ii) $\frac{n_2}{v}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$ R= - 6 cm, u = - 3cm , n_1 =1.5 n_2 = 1 $\frac{1}{v}+\frac{1.5}{3}=\frac{1-1.5}{-6}$	½	
	$\frac{1}{v}=\frac{0.5}{6}-\frac{1.5}{3}$	½	
	$\frac{1}{v}=\frac{0.5-3}{6}$	½	
	$\frac{1}{v}=\frac{-2.5}{6}$ v = - 2.4 cm from the left surface inside the sphere	½	5

	SECTION -E		
34.	a) Points at same potential 1 b) Current through arm bg 1 c) Potential difference across R_3 OR c) Power dissipated in R_2 2		
	a) Points (a, b, c) (d, e) (j, f, g ,h) are at same potential	1	
	Note: Give full credit if a student mentions any two points at same potential from the above. b)		
			
	According to Kirchhoff's loop rule for closed loop abgha $- 6 + 10\ I_2 + I_1 = 0$ $I_1 + 10\ I_2 = 6$ (i) for closed loop acfha $- 6 + 10\ (I_1 – I_2) + I_1 = 0$ $11\ I_1 - 10\ I_2 = 6$ (ii)		
	Adding (i) and (ii) $12\ I_1 = 12$ $I_1 = 1$ A	½	
	$I_2 = 0.5$ A = current through arm bg Note: Award 1 mark if a student calculates the current by any other method.	½	
	c) $V_{R3} = (I_1 - I_2) \times R_3$ $= 0.5 \times 5$	1	
	$= 2.5$ V OR	1	
	(c) $P = (I_1 - I_2)^2 \times R_2 = (0.5)^2 \times 5$	1	
	$= 1.25$ W	1	4

35.

a) Tracing of path of ray	1
b) Finding velocity of light	1
c) Explanation of two application of TIR	2
OR	
c) Definition of TIR	1
Mentioning two conditions of TIR	½ + ½

a)



1

From fig. angle of incidence on second face $\angle i = 60^0$

critical angle $\angle i_c = 24.5^o$

$(\angle i) > (\angle i_c)$

$\therefore$ TIR takes place

b) $n = \dfrac{c}{v}$

$$v = \frac{c}{n} = \frac{3\times10^8}{2.41} = 1.24 \times 10^8 \text{ m/s}$$ 1

c) Optical Fibre / Brilliance of diamond / mirage (any two)
Note: Give full credit if students mention the names of applications only. 1+1

OR

c) When light travels from optically denser medium to rarer medium at an interface and gets reflected back into the same medium the phenomenon is called as total internal reflection. 1

Conditions for TIR
1. Light must travel from optically denser medium to rarer medium.
2. Angle of incidence at the interface must be greater than the critical angle for the pair of media. ½ + ½

4

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2023
SUBJECT: PHYSICS (042) (PAPER CODE 55/1/2)

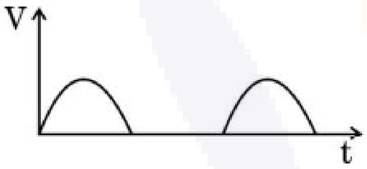
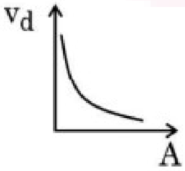
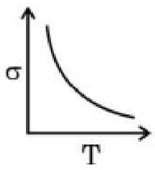
General Instructions : -

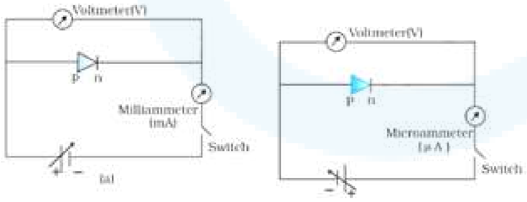
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓)while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.

9	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note **“Extra Question”**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0-70(example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any un assessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the “**Guidelines for spot Evaluation**” before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

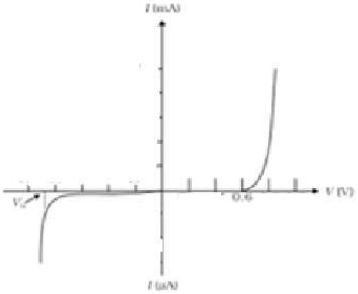
MARKING SCHEME: PHYSICS(042)

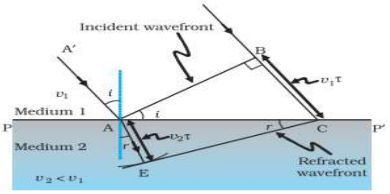
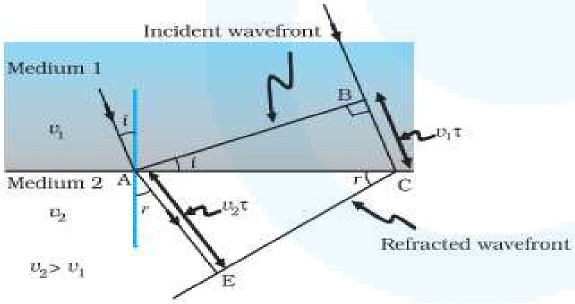
Code: 55/1/2

Q.No.	VALUE POINTS/EXPECTED ANSWERS	Marks	Total Marks
	SECTION -A		
1.	(b) Decreases in both A and B.	1	1
2.	(c) $\in_o \frac{d\phi_E}{dt}$	1	1
3.	(d) 4f	1	1
4.	Since no option is correct award 1 mark even if student does not attempt.	1	1
5.	(d) 95 nm	1	1
6.	(c) Number of protons in nucleus.	1	1
7.	(c) 	1	1
8.	(a) repelled by both the poles	1	1
9.	(c) 0.19 V	1	1
10.	(b) it becomes a p-type semiconductor	1	1
11.	(d) 0.01 eV	1	1
12.	(a) 	1	1
13.	Since no option is correct award 1 mark even if student does not attempt.	1	1
14.	(c) 	1	1
15.	(b) $\frac{\vec{F}}{8}$	1	1
16.	(a) Both Assertion (A) and Reason (R) are true and reason (R) is the correct explanation of the Assertion (A).	1	1
17.	(b) Both Assertion (A) and Reason (R) are true, but reason (R) is **not** the	1	1

<table>
<tr><td></td><td>correct explanation of the Assertion (A).</td><td></td><td></td></tr>
<tr><td>18.</td><td>(d) Assertion (A) is false and Reason (R) is also false.</td><td>1</td><td>1</td></tr>
<tr><td></td><td>SECTION-B</td><td></td><td></td></tr>
<tr><td>19.</td><td>
<table><tr><td>Formation of potential barrier 2</td></tr></table>
The diffusion current due to concentration gradient at the junction forms a space charge region consisting of immobile charge carriers. Due to this an electric field is generated at the junction giving rise to drift current in a direction opposite to diffusion current.
The potential at which diffusion current becomes equal to drift current is called potential barrier.</td><td>2</td><td>2</td></tr>
<tr><td>20.</td><td>(a)
<table><tr><td>Difference between intrinsic and extrinsic semiconductor 2</td></tr></table>
<table>
<tr><th>Intrinsic semiconductor</th><th>Extrinsic semiconductor</th></tr>
<tr><td>1. Pure semiconductor.</td><td>Semiconductor is Doped with impurities.</td></tr>
<tr><td>2. Low conductivity at room temperature.</td><td>High conductivity at room temperature.</td></tr>
<tr><td>3. $n_e = n_h$</td><td>$n_e \neq n_h$</td></tr>
</table>
(Any one)
Note: Give full credit if a student writes any other relevant correct answer.
OR
(b)
<table><tr><td>Circuit diagram for forward and reverse biased p-n junction diode ½ + ½
V-I characteristic (Forward and Reverse bias) ½ + ½</td></tr></table>


Forward Bias Reverse Bias</td><td>1+1
½ + ½</td><td></td></tr>
</table>

	 Characteristics of silicon Diode	½ + ½	2
21.	Calculation of acceleration of alpha particle 2 $\vec{F}=q(\vec{v}\times\vec{B})$ $= q(3\times10^5\hat{i}\times(0.4\hat{i}+0.3\hat{j}))N$ $\vec{F} = q(0.9\times10^5\hat{k})N$ $\vec{F} = m\vec{a} = q(0.9\times10^5\widehat{k})N$ $\vec{a}=\frac{q}{m}(0.9\times10^5\hat{k})ms^{-2}$ $= 4.8\times10^7\times0.9\times10^5\ \hat{k}\ ms^{-2}$ $= 4.32\times10^{12}\ \hat{k}\ ms^{-2}$ Note: Deduct ½ mark if a student does not mention the direction of acceleration.	½ ½ ½ ½	2
22.	a) Mentioning direction of electric field and magnetic field vectors 1 b) Finding ratio of energy densities 1 a) Electric field vector and magnetic field vector are along y-axis and z-axis or vice versa. b) $u_E = \frac{1}{2}\in_o E^2_o$ $u_B = \frac{1}{2}\frac{B^2_o}{\mu_o}$ $\frac{u_E}{u_B} = \mu_o \in_o \frac{E_o^2}{B_o^2}$ Using $\frac{E_o}{B_o} = c$ and $c = \frac{1}{\sqrt{\mu_o \in_o}}$ $\frac{u_E}{u_B} = \mu_o\varepsilon_o c^2 = 1$ Note: Award full credit of 1 mark even if a student finds ratio by taking u_E and u_B as equal.	1 ½ ½	2

23.	(a)		
	Ray diagram 1 Proof of Snell's law of refraction 1		
		1	
	AB is incident wave front, incident at an angle i. Let τ be time taken by the wavefront to travel distance BC. BC= v_1 τ where v_1 is speed of wave in medium 1. To determine shape of refracted wave front, we draw a sphere of radius v_2 τ, where v_2 is speed of wave in medium 2. CE represents a tangent drawn from point C on sphere, CE is the refracted wave front.		
	sin i = $\frac{BC}{AC} = \frac{v_1\tau}{AC}$ sin r = $\frac{AE}{AC} = \frac{v_2\tau}{AC}$	½	
	$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = n_{21}$	½	
	Note: Give full credit if student derives Snell's law by taking incident wavefront in denser medium.		
			

	(b) OR Reason for preferring reflecting type telescope over refracting telescope ½ + ½ Justification ½ + ½ 1 No Chromatic Aberration - No refraction in mirrors 2 No Spherical Aberration - Due to use of parabolic reflector 3 Easy mechanical support required - Mirrors weigh less and can be supported over entire back surface. 4 High resolving power – Due to Mirror with large diameter are better. 5 Brighter image – Large mirrors gather more light waves **(Any two)**	1+1	2
24.	Calculation of radius of curvature 2 P= 4D, n=1.5 $P=\frac{1}{f}=(n-1)(\frac{1}{R_1}-\frac{1}{R_2})$ $R_1 = R$, $R_2 = - R$ $P= \frac{1}{f}=(n-1)(\frac{2}{R})$ $4= (1.5-1)\ (\frac{2}{R})$ $4= (\frac{0.5\times 2}{R})$ $R= \frac{1}{4} = 0.25m =25\ cm$	½ ½ ½ ½	2
25.	Calculation of wave length of second line of Lyman series 2 $\frac{1}{\lambda}=R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$ For second line of Lyman series $n_1= 1$, $n_2= 3$ $\frac{1}{\lambda}=1.1\times10^7\left[\frac{1}{1^2}-\frac{1}{3^2}\right]$ $=1.1\times10^7\left[1-\frac{1}{9}\right]$ $=1.1\times10^7\times\frac{8}{9}$	½ ½	

<table>
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$=\frac{8.8}{9}\times10^{7}m^{-1}$

$\lambda=\frac{9}{8.8}\times10^{-7}m$

$= 1.023 \ \times10^{-7}m$

$= 1023$ Å

</td>
<td>½

½</td>
<td>

2</td>
</tr>
<tr>
<td></td>
<td>SECTION-C</td>
<td></td>
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<tr>
<td>26.</td>
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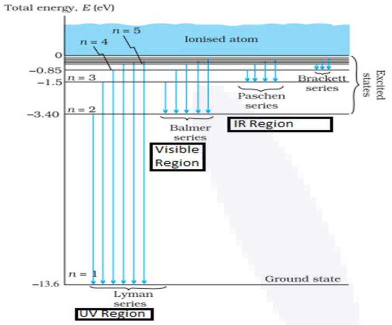
a)

Energy level diagram for hydrogen atom 1 ½
Transitions corresponding to ultraviolet region, visible region and infrared region ½ + ½ + ½

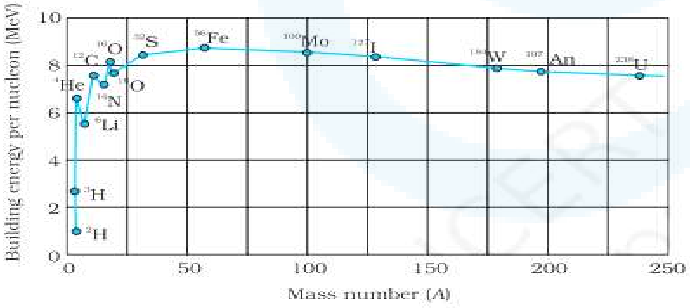


Note: Award 1 ½ mark for energy level diagram if a student does not show the transitions.

OR

b)

Diagram to show variation 1
Two features of diagram ½ + ½
Reason for nuclear fusion 1



(Note: Award full credit even if a student does not mark so many elements and does not mention the values of E_{bn}.)

Features of diagram (any two)
1. Binding energy per nucleon is practically independent of atomic number for nuclei of middle mass number (30 <A < 170)

</td>
<td>1 ½

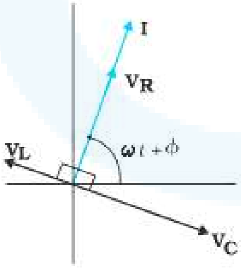
½

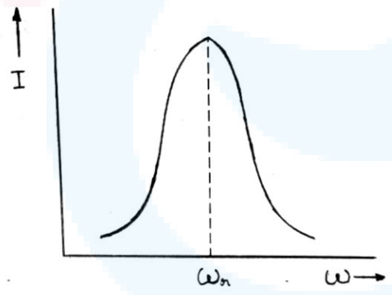
½

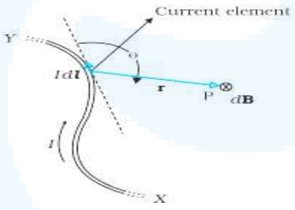
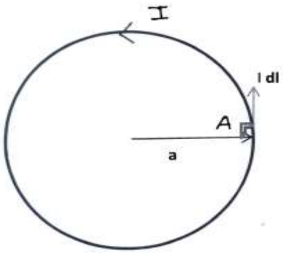
½

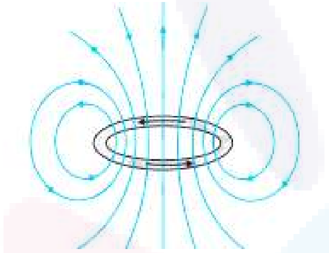
1</td>
<td></td>
</tr>
</table>

	2. The curve has maximum of about 8.75 MeV for A= 56 and has a value of 7.6 MeV for A= 238 3. Binding energy per nucleon is lower for both light nuclei (A<30) and heavy nuclei (A>170) Two lighter nuclei fuse together to form heavier nuclei as the binding energy per nucleon of fused heavier nuclei is more than the binding energy per nucleon of the lighter nuclei. Thus the final system is more tightly bound than initial system. **Alternatively** To attain the stability	½ + ½ 1	3
27.	Calculation of wave length of incident light 3 $\lambda_o = 3315Å$ K_{max} = 1.25 eV $= 1.25\times1.6\times10^{-19}J$ $=2\times10^{-19}J$ $=0.2\times10^{-18}J$ Work function $=\phi_o=\frac{hc}{\lambda_o}$ $=\frac{6.63\times10^{-34}\times3\times10^{8}}{3315\times10^{-10}}=0.6\times10^{-18}$ J Using hν = ϕ_o+K_{max} $\frac{hc}{\lambda}=\phi_o+K_{max}$ $=(0.6\times10^{-18}+0.2\times10^{-18})J$ $=0.8\times10^{-18}J$ $\lambda=\frac{hc}{0.8\times10^{-18}}=\frac{6.63\times10^{-34}\times3\times10^{8}}{0.8\times10^{-18}}$ $= 24.86 \times 10^{-8}$ m $= 2486 \times 10^{-10}$ m = 2486 Å	½ ½ ½ ½ ½ ½	3
28.	a) Calculation of Voltage 1 b) Calculation of current 1 c) Calculation of average power 1 N_p =650, N_s = 25 ,V_p =240V, I_p =1.5A a) $\frac{V_s}{V_p}=\frac{N_s}{N_p}$	½	

	$V_s = \frac{N_s}{N_p}\times V_p = \frac{25}{650}\times 240$		
	$= \frac{120}{13}$		
	$= 9.23\text{V}$	½	
	b) $\frac{N_s}{N_p} = \frac{I_p}{I_s}$	½	
	$I_s = \frac{N_p \times I_p}{N_s} = \frac{650\times 1.5}{25} = 39A$	½	
	c) $P_{av} = V_s I_s$	½	
	$= \frac{120}{13}\times 39 = 360W$	½	
			3
29.	(a)		
	Difference between resistance and impedance 1 Obtaining expression for impedance 2		
	1. Resistance is the opposition offered to both alternating current and direct current while impedance is the opposition offered to alternating current only. 2. Resistance is independent of frequency of source while impedance depends on frequency. 3. Resistance is opposition offered by material of the conductor while impedance is combined opposition offered by different electrical components such as resistor, inductor or capacitor.	1	
	(Any One) (Note: Give credit of this part if a student writes any other correct answer.)		
		½	
	$V_R = i_m R$, $V_c = i_m X_c$, $V_L = i_m X_L$ i_m = Peak value of current in the circuit. $\vec{V_L} + \vec{V_R} + \vec{V_C} = \vec{V_m}$ $(V_m)^2 = V_R^2 + (V_C - V_L)^2$ $= (i_m R)^2 + (i_m X_c - i_m X_L)^2$	½	

	$= i_m [R^2 + (X_c - X_L)^2]$ $i_m = \frac{V_m}{\sqrt{R^2+(X_c-X_L)^2}}$ $i_m = \frac{V_m}{Z}$ where $Z = \sqrt{R^2+(X_c-X_L)^2}$ = impedance OR (b) Finding condition for resonance 1 Factors affecting resonant frequency 1 Graph 1 $Z = \sqrt{R^2+(X_L-X_c)^2}$ For maximum current, Z should be minimum therefore to minimize Z $X_L = X_C$ **Alternatively** $X_L = X_C$ $\omega L = \frac{1}{\omega C}$ $\omega_r = \frac{1}{\sqrt{LC}}$ Resonant Frequency depends on value of Inductance and Capacitance  	½ ½ ½ ½ ½ ½ ½ + ½ 1	3
30.	a) Calculation of electrostatic energy stored by the capacitor 1 b) Calculation of electrostatic energy stored by system 2 C= 100 $\mu F = 100 \times 10^{-6} F, V = 12V$ a) U = $\frac{1}{2} CV^2$	½	

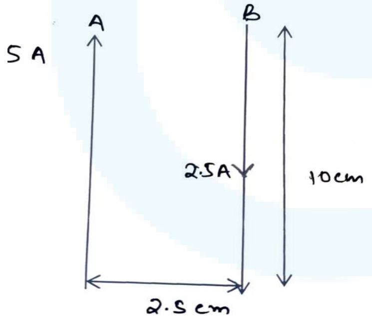
	$= \frac{1}{2}\times100\times10^{-6}\times(12)^2$ $=\frac{1}{2}\times10^{-4}\times144$	½	
	$= 72\times10^{-4}$ J = 7.2 m J b) $C_{eq} = C_1 + C_2$ $= 200\ \mu F$	½	
	$Q = CV$ $= 100\times10^{-6}\times12$	½	
	$= 12\times10^{-4}C$ $U = \frac{Q^2}{2C_{eq}} = \frac{(12\times10^{-4})^2}{2\times200\times10^{-6}}$	½	
	$= \frac{144}{4}\times10^{-4}$		3
	$= 36\times10^{-4}$J = 3.6 m J	½	
	SECTION-D		
31	(a) i) Statement of Biot-Savart's law 1 Expression for magnetic field 2 Diagram for magnetic field lines ½ ii) Finding current by revolving electron 1 ½		
	(i) The magnetic field at a point due to a current carrying element is proportional to magnitude of current, element length and inversely proportional to the square of the distance from the element.	1	
	$\vec{dB} = \frac{\mu_o}{4\pi} I \frac{\vec{dl}\times\vec{r}}{r^3}$ $\|dB\| = \frac{\mu_o}{4\pi}\frac{Idl\sin\theta}{r^2}$  Consider a circular coil of radius a carrying current I.		
		½	
	According to Biot-Savart's law		

	$\left\lvert \overrightarrow{dB} \right\rvert = \frac{\mu_o}{4\pi}\frac{Idl\sin\theta}{r^2}$ At point A I $\overrightarrow{dl} \perp \vec{a}$ $\therefore \theta = 90^o, \sin 90^o = 1$	½	
	Hence dB= $\frac{\mu_o}{4\pi}\frac{Idl}{a^2}$ Magnetic field at centre B= $\int_{o}^{2\pi a} dB = \int_{0}^{2\pi a}\frac{\mu_o}{4\pi}\frac{Idl}{a^2}$ B= $\frac{\mu_o}{4\pi}\times\frac{I}{a^2}\times 2\pi a$	½	
	B = $\frac{\mu_o I}{2a}$ Note: Give full credit of 2 marks if a student derives the expression for magnetic field at the axis of the loop and then puts distance of point as 0 from the centre.	½	
		½	
	ii) q=e , v=10^7ms^{-1},r=10^{-10}m i= $\frac{q}{T}$ = $\frac{\text{qv}}{2\pi\text{r}}$	½	
	= $\frac{\text{ev}}{2\pi\text{r}}$ = $\frac{1.6\times10^{-19}\times10^{7}}{2\times\pi\times10^{-10}}$	½	
	= $\frac{0.8}{\pi}\times10^{-2} A$ = 0.255 $\times10^{-2} A$ = 2.55 mA	½	

OR

b)

i) Derivation of expression for force	2
Statement of Rule	½
Conditions for maximum and minimum force	½ + ½
ii) Calculation of magnitude of force	1 ½

	Consider a rod of uniform cross sectional area A and length *l*. Let the number density of mobile charge carriers in it be n.	½	
	Thus the total number of mobile charge carriers in it is n *l* A. For steady current I, drift velocity of electrons $\overrightarrow{v_d}$, in the presence of external magnetic field $\vec{B}$, the force on these carriers is	½	
	$\vec{F} = n\,l\,Aq(\overrightarrow{v_d} \times \vec{B})$ $= \left[\vec{j}Al\right] \times \vec{B}$	½	
	$= I(\vec{l} \times \vec{B})$	½	
	Where $nq\overrightarrow{v_d}$ is current density ($\vec{j}$) and $\left\lvert \vec{j}A \right\rvert$ is current (I) Fleming's left hand Rule: If forefinger, middle finger and thumb are stretched in mutually perpendicular directions, such that forefinger indicates the direction of magnetic field, middle finger indicates the direction of current in the conductor, then thumb indicates the direction of force on the conductor. Or Right Hand Thumb Rule : If the fingers of right hand are made to rotate from	½	
	$\vec{l}\; to\; \vec{B}$ through angle θ, the thumb points in the direction of force on the current carrying conductor. Condition for maximum force $\theta = 90^0$	½	
	$\left\lvert \vec{F} \right\rvert = I\,l\,B \sin\theta$ = I *l* B Condition for minimum force $\theta = 0^o$ or 180^0	½	
	$\left\lvert \vec{F} \right\rvert = 0$ ii) 		
	F= $\dfrac{\mu_o}{4\pi} \dfrac{2I_1I_2}{d}\, l$	½	
	$= \dfrac{10^{-7} \times 2 \times 5 \times 2.5}{2.5 \times 10^{-2}} \times 10 \times 10^{-2} N$	½	
	= 10^{-5} N	½	5

32\. a)

i) (1) Difference between interference pattern and diffraction pattern	1+1
(2) Two factors affecting fringe width in young's double slit experiment	½ + ½
ii) (1) calculation of angular separation	1
(2) calculation of distance between two maxima	1

(i) (1)

(a) The interference pattern has a number of equally spaced bright and dark bands while diffraction pattern has a central bright maximum which is twice as wide as the other maxima.

(b) Interference pattern is obtained by superposing two waves originating from two narrow slits, while diffraction pattern is a superposition of a continuous family of waves originating from each point on a single slit.

(c) The maxima in interference pattern is obtained at angle λ / a, while the first minima is obtained at same angle λ / a for diffraction pattern.

(d) in interference pattern the intensity of bright fringes remain same while in diffraction the intensity falls as we go to successive maxima away from the center on either side. 1+1

(any two)

(2) Factors affecting fringes width

Wave length (λ) / distance of screen from slits (D) / separation between slits (d). ½ + ½

(any two)

(ii) (1) $d \sin\theta = n\lambda$ ½

$n=1$

$$\sin\theta = \frac{\lambda}{d}$$

For small angle $\sin\theta \approx \theta = \frac{\lambda}{100\lambda} = \frac{1}{100}$ radian. ½

(2) $\beta = \frac{\lambda D}{d} = \theta D$ ½

$= \frac{1}{100} \times 50 \times 10^{-2}$

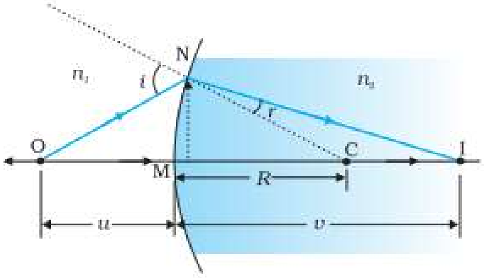
$= 50 \times 10^{-4} m$ ½

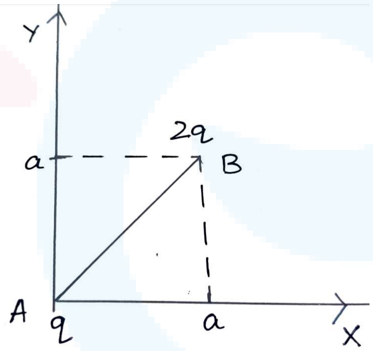
$= 5$ mm

OR

(b)

i) Derivation of relation between u and v	3
ii) Finding apparent position	2

		1	
	Assume that the aperture of the surface is small as compared to other distance involved, so that small angle approximation can be made. For small angles for ΔNOC, i is the exterior angle $\therefore$ i = $\angle NOM + \angle NCM$ i= $\frac{MN}{OM}+\frac{MN}{MC}$ (i) Similarly r = $\angle NCM - \angle NIM$ $=\frac{MN}{MC}-\frac{MN}{MI}$ (ii)	½	
	By Snell's law n_1Sin i = n_2 Sin r for small angles n_1 i = n_2 r	½	
	substituting i and r from (i) and (ii) we get $\frac{n_1}{OM}+\frac{n_2}{MI}=\frac{n_2-n_1}{MC}$	½	
	Applying Cartesian coordinates OM= -u, MI= + v , MC= +R $\frac{n_2}{\text{v}}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$	½	
	(ii) $\frac{n_2}{\text{v}}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$	½	
	R= - 6 cm, u = - 3cm , n_1 =1.5 n_2 = 1 $\frac{1}{\text{v}}+\frac{1.5}{3}=\frac{1-1.5}{-6}$	½	
	$\frac{1}{\text{v}}=\frac{0.5}{6}-\frac{1.5}{3}$ $\frac{1}{\text{v}}=\frac{0.5-3}{6}$	½	
	$\frac{1}{\text{v}}=\frac{-2.5}{6}$ v = - 2.4 cm from the left surface inside the sphere	½	5

33.	(a) i) Statement of coulomb's law and vector form 1+1 ii) Explanation of Gauss's law based on coulomb's law 1 iii) Force exerted by charge A on charge B 2		
	i) Force between two point charges varies inversely with the square of distance between the charges and is directly proportional to the product of magnitude of the two charges and acts along the line joining the two charges.	1	
	$\overrightarrow{F_{12}} = \frac{1}{4\pi \in_o} \frac{q_1 q_2}{r_{12}^2} \widehat{r_{12}}$	1	
	Alternatively $\overrightarrow{F_{12}} = \frac{1}{4\pi \in_o} \frac{q_1 q_2}{r_{12}^3} \overrightarrow{r_{12}}$ Where $\overrightarrow{r_{12}}$ is a vector from charge q_2 to charge q_1.		
	ii) In derivation of Gauss's law, flux is calculated using Coulomb's law and surface area. Here coulomb's law involves $\frac{1}{r^2}$ factor and surface area involves r^2 factor. When product is taken, the two factors cancel out and flux becomes independent of r.	1	
	iii)  	½	
	$\vec{r} = \overrightarrow{AB} = a\hat{i} + a\hat{j}$	½	
	r = $\lvert\overrightarrow{AB}\rvert = \sqrt{a^2 + a^2} = \sqrt{2}a$ $\vec{F} = \frac{1}{4\pi \in_o} \frac{q_1 q_2}{r^2} \hat{r}$		
	$\vec{F} = \frac{1}{4\pi \in_o} \times \frac{q \times 2q}{(\sqrt{2}a)^2} \times \frac{(a\hat{i} + a\hat{j})}{\sqrt{2}a}$	½	
	$\vec{F} = \frac{1}{4\pi \in_o} \times \frac{2q^2}{2a^2} \times \frac{(\hat{i} + \hat{j})}{\sqrt{2}}$		

$$\vec{F} = \frac{1}{4\pi \in_o} \times \frac{q^2}{\sqrt{2a^2}} \times (\hat{i} + \hat{j})$$

$$\vec{F} = \frac{q^2}{4\sqrt{2}\pi \in_o a^2}(\hat{i} + \hat{j})$$ ½

Note: Award 1 mark if a student calculates the magnitude of force only.

$$|\vec{F}| = \frac{1}{4\pi \in_o}\frac{q^2}{a^2}$$

Alternatively

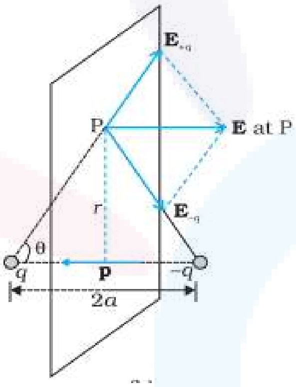
Give full credit if a student uses component method to solve the question.

OR

(b)

i) Derivation of electric field	2
ii) Effect on electric field	1
iii) Finding magnitude and direction of electric field	2

i)



½

$$E_{+q} = \frac{q}{4\pi \in_o} \times \frac{1}{r^2 + a^2}$$

$$E_{-q} = \frac{q}{4\pi \in_o} \times \frac{1}{r^2 + a^2}$$ ½

The components normal to dipole axis cancel away. The components along the dipole axis add up. ½

Total electric field is opposite to dipole moment.

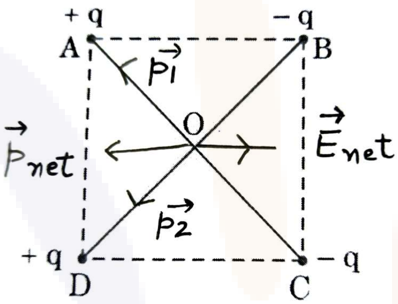
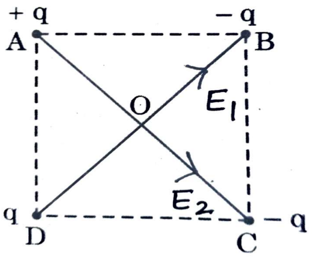
$$\vec{E} = -(E_{+q} + E_{-q})\cos\theta\,\hat{p}$$

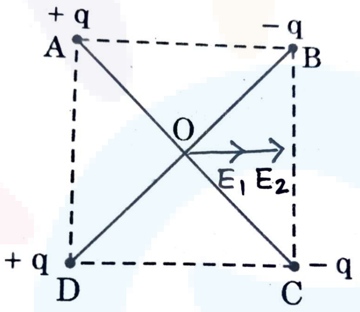
$$= \frac{-2qa}{4\pi \in_o (r^2 + a^2)^{3/2}}\hat{p}$$ ½

$$= \frac{-\vec{p}}{4\pi \in_o (r^2 + a^2)^{3/2}}$$

Deduct ½ mark if the expression of electric field is not in vector form.

ii) At far off point r >> a

	$\vec{E} = \frac{-\vec{p}}{4\pi \in_o r^3}$ When distance is halved.	½	
	$\vec{E} = \frac{-\vec{p}}{4\pi \in_o (\frac{r}{2})^3}$ $= \frac{-8\vec{p}}{4\pi \in_o r^3}$ $\vec{E}$ becomes 8 times	½	
	iii)  $p_1 = q \times 2\,Cm$ (along OA) $p_2 = q \times 2\,Cm$ (along OD)	½	
	$p_{net} = \sqrt{p_1^2 + p_2^2}$ $= 2\sqrt{2}\,q\,Cm$ Electric field at centre O	½	
	$E = \frac{kp_{net}}{(r^2+a^2)^{3/2}}$ at point O, r = 0 , a = 1 m	½	
	$E = \frac{k \times 2\sqrt{2}q}{1^3} = 2\sqrt{2}kq = \frac{2\sqrt{2}q}{4\pi \in_o}$ Along DC	½	
	Alternatively  $E = \frac{kq}{r^2}$		

	AC= BD= 2m		
	r = OA =OB= OC=OD=1m	½	
	Electric field at O due to charges at B and D		
	$E_1 = E_B + E_D$		
	$E_1 = \frac{kq}{1^2} + \frac{kq}{1^2}$ along OB		
	$= 2kq$	½	
	Electric field at O due to charges at A and C		
	$E_2 = E_A + E_C$		
	$E_2 = \frac{kq}{1^2} + \frac{kq}{1^2}$	½	
	$= 2kq$ along OC		
	$E_{net} = \sqrt{E_1^2 + E_2^2}$		
	$= 2\sqrt{2}\ kq = \frac{2\sqrt{2}q}{4\pi \in_o}$		
	Along DC	½	
	Alternatively		
			
	Considering AB as dipole, electric field at O		
	$E_1 = \frac{2kq \times a}{((\frac{1}{\sqrt{2}})^2 + (\frac{1}{\sqrt{2}})^2)^{3/2}} = \frac{2kqa}{(\frac{1}{2}+\frac{1}{2})^{3/2}} = 2kqa$		
	Similarly considering DC as another dipole, electric field at O	½	
	$E_2 = \frac{2kq \times a}{((\frac{1}{\sqrt{2}})^2 + (\frac{1}{\sqrt{2}})^2)^{3/2}} = \frac{2kqa}{(\frac{1}{2}+\frac{1}{2})^{3/2}} = 2kqa$		
	$E_{net} = E_1 + E_2 = 4kqa = \frac{1}{4\pi \in_o} \times 4 \times \frac{1}{\sqrt{2}} \times q$	½	
	$= 2\sqrt{2}kq = \frac{2\sqrt{2}q}{4\pi \in_o}$	½	
	Along DC	½	5

SECTION - E

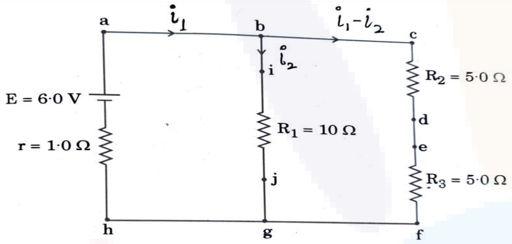
34.

a) Points at same potential	1
b) Current through arm bg	1
c) Potential difference across R_3	
OR	
c) Power dissipated in R_2	2

a) Points (a, b, c)
(d, e) 1
(j, f, g ,h)
are at same potential

Note: Give full credit if a student mentions any two points at same potential from the above.

b)

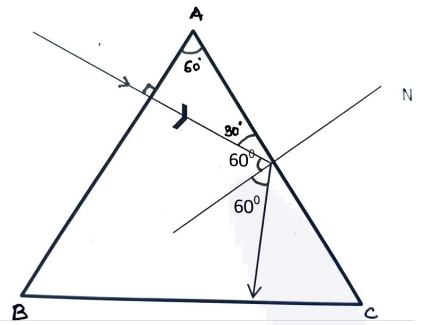


According to Kirchhoff's loop rule
for closed loop abgha
$- 6 + 10\ I_2 + I_1 \ = 0$
$I_1 \ + 10\ I_2 \ = 6$ (i) ½
for closed loop acfha
$- 6 + 10\ (I_1 – I_2\ ) + I_1 \ = 0$
$11\ I_1 - 10\ I_2 \ = 6$ (ii)
Adding (i) and (ii)
$12\ I_1 \ = 12$ ½
$I_1 = 1$ A
$I_2 = 0.5$ A
= current through arm bg
Note: Award 1 mark if a student calculates the current by any other method.

c) $V_{R3} \ = (I_1 - I_2) \times R_3$ 1
$= 0.5 \times 5$
$= 2.5$ V 1

OR

$P = (I_1 - I_2)^2 \times R_2 \ = (0.5)^2 \times 5$ 1
$= 1.25$ W 1 4

35.	a) Tracing of path of ray 1 b) Finding velocity of light 1 c) Explanation of two application of TIR 2 OR c) Definition of TIR 1 Mentioning two conditions of TIR ½ + ½		
	a)  From fig. angle of incidence on second face $\angle i = 60^0$ critical angle $\angle i_c = 24.5^o$ $(\angle i) > (\angle i_c)$ ∴ TIR takes place	1	
	b) n= $\frac{c}{v}$ v = $\frac{c}{n} = \frac{3\times10^8}{2.41} = 1.24 \times 10^8$ m/s	1	
	c) Optical Fibre / Brilliance of diamond / mirage (any two) Note: Give full credit if students mention the names of applications only.	1+1	
	OR		
	c) When light travels from optically denser medium to rarer medium at an interface and gets reflected back into the same medium the phenomenon is called as total internal reflection.	1	
	Conditions for TIR 1. Light must travel from optically denser medium to rarer medium. 2. Angle of incidence at the interface must be greater than the critical angle for the pair of media.	½ + ½	4

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2023
SUBJECT : PHYSICS (042) (PAPER CODE 55/1/3)

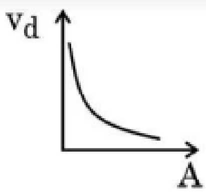
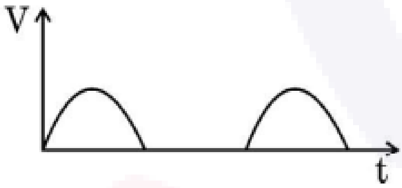
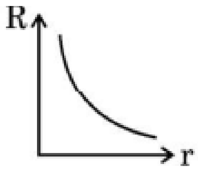
General Instructions : -

1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓) while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be

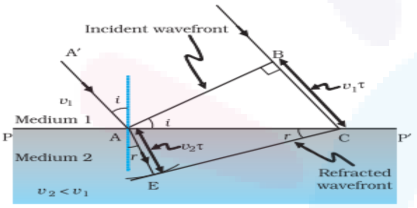
	retained and the other answer scored out with a note **“Extra Question”**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks __________(example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any un assessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the “**Guidelines for spot Evaluation**” before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

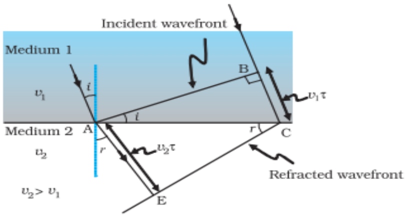
MARKING SCHEME: PHYSICS(042)

Code: 55/1/3

Q.No.	VALUE POINTS/EXPECTED ANSWERS	Marks	Total Marks
	SECTION -A		
1.	(d) 0.01 eV	1	1
2.	(a) 	1	1
3.	(c) 	1	1
4.	(d) 95 nm	1	1
5.	(c) $\in_o \frac{d\phi_E}{dt}$	1	1
6.	(a) 3.0 eV	1	1
7.	(c) 0.19 V	1	1
8.	(d) 1:1	1	1
9.	(b) $\frac{\vec{F}}{8}$	1	1
10.	(d) 5.3 A	1	1
11.	(b) it becomes a p-type semiconductor	1	1
12.	(a) repelled by both the poles	1	1
13.	(d) Diamond to air	1	1
14.	(c) Less than g	1	1
15.	(c) 	1	1
16.	(b) Both the assertion (A) and Reason (R) are true , but Reason (R) is **not** the correct explanation of the Assertion (A).	1	1
17.	(d) Assertion (A) is false and Reason (R) is also false.	1	1

18.	(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correctly explanation of the Assertion (A).	1	1
	SECTION-B		
19.	Finding refractive index of the glass 2 R_1 =20 cm, R_2 =-30 cm P = $\frac{25}{6}D=\frac{25}{600}cm^{-1}$ P= (n-1) $(\frac{1}{R_1}-\frac{1}{R_2})$ $\frac{25}{600}=(n-1)(\frac{1}{20}+\frac{1}{30})$ $\frac{25}{600}=(n-1)(\frac{50}{20\times30})$ 25= (n-1)50 n-1= $\frac{1}{2}$ n= $\frac{3}{2}$	½ ½ ½ ½	2
20.	Formation of potential barrier 2 The diffusion current due to concentration gradient at the junction forms a space charge region consisting of immobile charge carriers. Due to this an electric field is generated at the junction giving rise to drift current in a direction opposite to diffusion current. The potential at which diffusion current becomes equal to drift current is called potential barrier.	2	2
21.	Calculation of acceleration of alpha particle 2 $\vec{F}=q(\vec{v}\times\vec{B})$ $= q(3\times10^5\hat{i}\times(0.4\hat{i}+0.3j))N$ $\vec{F} = q(0.9\times10^5k)N$ $\vec{F}$ = m $\vec{a}$ = $q(0.9\times10^5k)N$ $\vec{a}=\frac{q}{m}(0.9\times10^5k)ms^{-2}$ = $4.8\times10^7\times0.9\times10^5$ k ms^{-2} = 4.32×10^{12} k ms^{-2} Note: Deduct ½ mark if a student does not mention the direction of acceleration.	½ ½ ½ ½	2

22.	Calculating wavelength of spectral line 2 $\Delta E = E_2 - E_1$ $= (-1.51-(-3.4))\text{eV}$ $= 1.89\text{eV}$ $=1.89 \times 1.6\times 10^{-19}\text{ J}$ $\Delta E = \frac{hc}{\lambda}$ $\lambda = \frac{hc}{\Delta E} = \frac{6.63\times10^{-34} \times 3\times10^{8}}{1.89\times1.6\times10^{-19}} m$ $= 6.58\times10^{-7} m$ $= 658\text{nm}$	½ ½ ½ ½	2
23.	(a) Ray diagram 1 Proof of Snell's law of refraction 1  AB is incident wave front, incident at an angle i. Let τ be time taken by the wave front to travel distance BC. BC= $v_1 \tau$ where v_1 is speed of wave in medium 1. To determine shape of refracted wave front, we draw a sphere of radius $v_2 \tau$, where v_2 is speed of wave in medium 2. CE represents a tangent drawn from point C on sphere, CE is the refracted wave front. $\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$ $\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$ $\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = n_{21}$ **Note:** Give full credit if student derives Snell's law by taking incident wave front in denser medium.	1 ½ ½	



OR

(b)

Reason for preferring reflecting type telescope over refracting telescope ½ + ½
Justification ½ + ½

1 No Chromatic Aberration - No refraction in mirrors
2 No Spherical Aberration - Due to use of parabolic reflector
3 Easy mechanical support required - Mirrors weigh less and can be supported over entire back surface.
4 High resolving power – Due to Mirror with large diameter are better. 1+1 2
5 Brighter image – Large mirrors gather more light waves.

(Any two)

24.

(a)Identification and use ½ + ½
(b) Identification and use ½ + ½

a) Infrared Rays ½
Uses: -Muscular pain therapy
(any one) -Remote control
- Photography in foggy conditions ½

b) X-rays
Uses: -To study crystal structure ½
(any one) -Detection of fracture in bones
-Cancer treatment ½

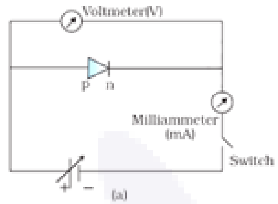
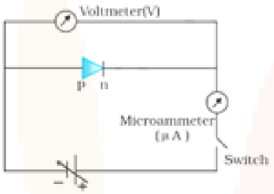
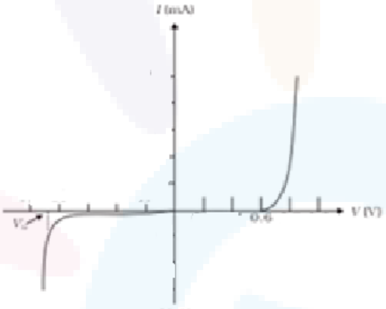
Any other correct use. 2

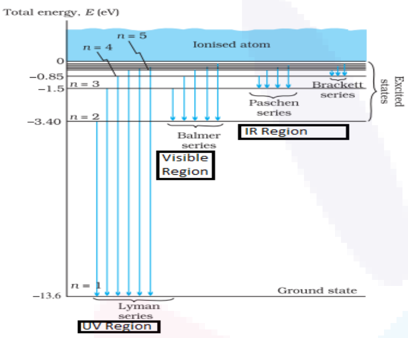
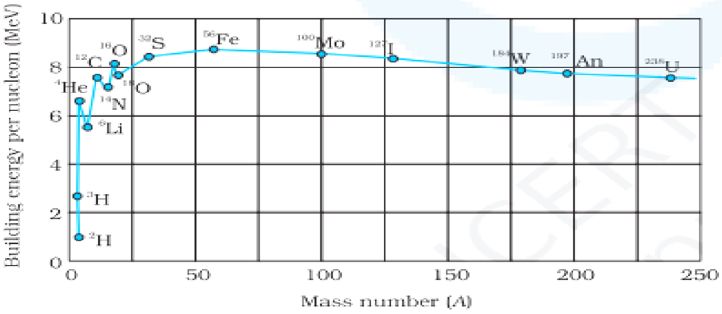
25. (a)

Difference between intrinsic and extrinsic semiconductor 2

Intrinsic semiconductor	Extrinsic semiconductor
1. Pure semiconductor.	Semiconductor is Doped with impurities.
2. Low conductivity at room temperature.	High conductivity at room temperature.
3. $n_e = n_h$	$n_e \neq n_h$

1+1

	(Any one) Note: Give full credit if a student writes any other relevant correct answer. OR (b) Circuit diagram for forward and reverse biased p-n junction diode ½ + ½ V-I characteristic (Forward and Reverse bias) ½ + ½  Forward Bias  Reverse Bias  Characteristics of silicon Diode	½ + ½ ½ + ½	2
	SECTION-C		
26.	(a) Calculation of reactance of capacitor 1 (b) Calculation of amplitude of current 1 Writing expression of current 1 $V = V_m \sin\omega\, t$ $C = 15\times10^{-6} F$ $V = 310 \sin 100\,\pi t$ i) $X_c = \dfrac{1}{\omega C}$ $= \dfrac{1}{100\pi\times15\times10^{-6}}$ $= \dfrac{10^4}{15\pi} = 212\ \Omega$	½ ½	

	ii) $i_m = \frac{V_m}{X_c}$ $= \frac{310}{212}$ = 1.46 A Equation of current i= $i_m \sin(\omega t + \frac{\pi}{2})$ = 1.46 sin (100 $\pi t + \frac{\pi}{2}$)	½ ½ 1	3
27.	a) Energy level diagram for hydrogen atom 1 ½ Transitions corresponding to ultraviolet region, visible region and infrared region ½ + ½ + ½  Note: Award 1 ½ mark for energy level diagram if a student does not show the transitions. OR b) Diagram to show variation 1 Two features of diagram ½ + ½ Reason for nuclear fusion 1  (Note: Award full credit even if a student does not mark so many elements and does not mention the values of E_{bn}.) Features of diagram **(any two)** 1. Binding energy per nucleon is practically independent of atomic number	1 ½ ½ ½ ½ 1	

	for nuclei of middle mass number (30 <A < 170) 2. The curve has maximum of about 8.75 MeV for A= 56 and has a value of 7.6 MeV for A= 238 3. Binding energy per nucleon is lower for both light nuclei (A<30) and heavy nuclei (A>170) Two lighter nuclei fuse together to form heavier nuclei as the binding energy per nucleon of fused heavier nuclei is more than the binding energy per nucleon of the lighter nuclei. Thus the final system is more tightly bound than initial system. **Alternatively** To attain the stability	½ + ½ 1	3
28.	Calculating Electrostatic potential Energy 3 $U_{Q1Q2} = \frac{1}{4\pi \in_o}\frac{Q_1Q_2}{r_{12}}$ $= \frac{9\times10^9\times(-15\times10^{-6})\times(10\times10^{-6})}{3\times10^{-2}}$ = - 45 J $U_{Q2Q3} = \frac{1}{4\pi \in_o}\frac{Q_2Q_3}{r_{23}}$ $= \frac{9\times10^9\times(10\times10^{-6})\times(16\times10^{-6})}{4\times10^{-2}}$ = 36 J $U_{Q1Q3} = \frac{1}{4\pi \in_o}\frac{Q_1Q_3}{r_{13}}$ $= \frac{9\times10^9\times(-15\times10^{-6})\times(16\times10^{-6})}{5\times10^{-2}}$ = - 43.2 J $U_{net} = U_{Q1Q2} + U_{Q2Q3} + U_{Q1Q3}$ = -45+36-43.2 = -52.2 J **Alternatively** $U = k(\frac{Q_1Q_2}{r_{12}} + \frac{Q_2Q_3}{r_{23}} + \frac{Q_1Q_3}{r_{13}})$ $= \frac{9\times10^9\times(-15\times10^{-6})\times(10\times10^{-6})}{3\times10^{-2}} + \frac{9\times10^9\times(10\times10^{-6})\times(16\times10^{-6})}{4\times10^{-2}} + \frac{9\times10^9\times(-15\times10^{-6})\times(16\times10^{-6})}{5\times10^{-2}}$ =(-45 +36-43.2) J = 52.2 J	½ ½ ½ ½ ½ ½ 1 1 1	3

29. (a)

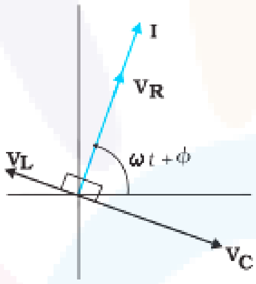
Difference between resistance and impedance	1
Obtaining expression for impedance	2

1. Resistance is opposition offered to both alternating current and direct current while impedance is opposition offered to alternating current only.

2. Resistance is independent of frequency of source while impedance depends on frequency.

3. Resistance is opposition offered by material of the conductor while impedance is combined opposition offered by different electrical components such as resistor, inductor or capacitor. 1

(Any One)
(Note: Give credit of this part if a student writes any other correct answer.)



½

$V_R = i_mR$, $V_c = i_m X_c$, $V_L = i_mX_L$
i_m = Peak value of current in the circuit.
$\vec{V_L} + \vec{V_R} + \vec{V_C} = \vec{V_m}$ ½
$(V_m)^2 = V_R^2 + (V_C - V_L)^2$
$= (i_mR)^2 + (i_mX_c - i_mX_L)^2$ ½
$= i_m [R^2 + (X_c - X_L)^2]$

$$i_m = \frac{V_m}{\sqrt{R^2+(X_c-X_L)^2}}$$

$i_m = \frac{V_m}{Z}$ where $Z = \sqrt{R^2+(X_c-X_L)^2}$ = impedance ½

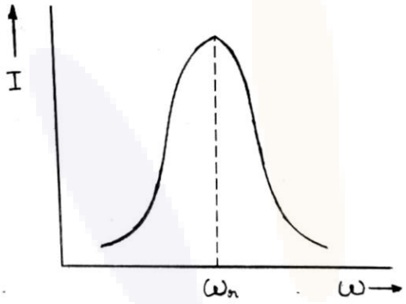
OR

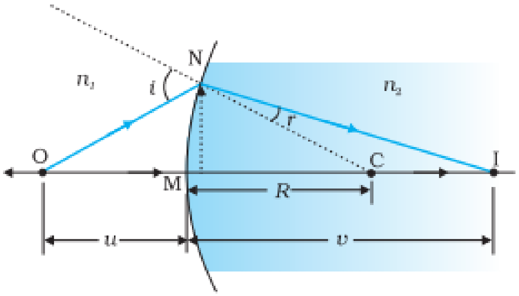
(b)

Finding condition for resonance	1
Factors affecting resonant frequency	1
Graph	1

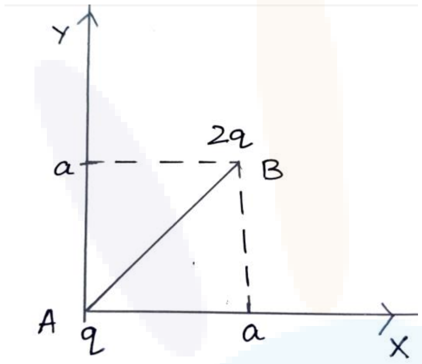
$Z = \sqrt{R^2+(X_L-X_c)^2}$ ½

For maximum current, Z should be minimum therefore to minimize Z
$X_L = X_C$ ½

	Alternatively $X_L = X_C$ $\omega L = \frac{1}{\omega C}$ $\omega_r = \frac{1}{\sqrt{LC}}$ Resonant Frequency depends on value of Inductance and Capacitance 	½ ½ ½ + ½ 1	3
30.	Calculating wavelength of wave 3 $\lambda = \frac{h}{\sqrt{2mK}}$ $\lambda' = \frac{h}{\sqrt{2m \times 4K}}$ $= \frac{1}{2}\frac{h}{\sqrt{2mK}}$ $= \frac{\lambda}{2}$ $= \frac{1.2nm}{2}$ $= 0.6nm$	½ ½ 1 ½ ½	3
	SECTION-D		
31	a) i) (1) Difference between interference pattern and diffraction pattern 1+1 (2) Two factors affecting fringe width in young's double slit experiment ½ + ½ ii) (1) calculation of angular separation 1 (2) calculation of distance between two maxima 1		

	(i) (1) (a) The interference pattern has a number of equally spaced bright and dark bands while diffraction pattern has a central bright maximum which is twice as wide as the other maxima. (b) Interference pattern is obtained by superposing two waves originating from two narrow slits, while diffraction pattern is a superposition of a continuous family of waves originating from each point on a single slit. I The maxima in interference pattern is obtained at angle λ / a, while the first minima is obtained at same angle λ / a for diffraction pattern. (d) in interference pattern the intensity of bright fringes remain same while in diffraction the intensity falls as we go to successive maxima away from the center on either side. **(any two)**	1+1	
	(2) Factors affecting fringes width Wave length (λ) / distance of screen from slits (D) / separation between slits (d). **(any two)**	½ + ½	
	(ii) (1) d sinθ = nλ n=1 $\sin\theta = \frac{\lambda}{d}$	½	
	For small angle $\sin\theta \approx \theta = \frac{\lambda}{100\lambda} = \frac{1}{100}$ radian.	½	
	(2) $\beta = \frac{\lambda D}{d} = \theta D$	½	
	$= \frac{1}{100} \times 50 \times 10^{-2}$ $= 50 \times 10^{-4} m$ = 5 mm	½	
	OR (b) i) Derivation of relation between u and v 3 ii) Finding apparent position 2 	1	
	Assume that the aperture of the surface is small as compared to other distance involved, so that small angle approximation can be made. For small angles		

	for ΔNOC, I is the exterior angle $\therefore$ I = $\angle NOM + \angle NCM$ i= $\frac{MN}{OM}+\frac{MN}{MC}$ (i) Similarly r = $\angle NCM - \angle NIM$ $= \frac{MN}{MC}-\frac{MN}{MI}$ (ii) By Snell's law n_1Sin I = n_2 Sin r for small angles n_1 I = n_2 r substituting I and r from (i) and (ii) we get $\frac{n_1}{OM}+\frac{n_2}{MI}=\frac{n_2-n_1}{MC}$ Applying Cartesian coordinates OM= -u, MI= + v , MC= +R $\frac{n_2}{v}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$ (ii) $\frac{n_2}{v}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$ R= - 6 cm, u = - 3cm , n_1 =1.5 n_2 = 1 $\frac{1}{v}+\frac{1.5}{3}=\frac{1-1.5}{-6}$ $\frac{1}{v}=\frac{0.5}{6}-\frac{1.5}{3}$ $\frac{1}{v}=\frac{0.5-3}{6}$ $\frac{1}{v}=\frac{-2.5}{6}$ v = - 2.4 cm from the left surface inside the sphere	½ ½ ½ ½ ½ ½ ½ ½	5
32.	(a) i) Statement of coulomb's law and vector form 1+1 ii) Explanation of Gauss's law based on coulomb's law 1 iii) Force exerted by charge A on charge B 2 i) Force between two point charges varies inversely with the square of distance between the charges and is directly proportional to the product of magnitude of the two charges and acts along the line joining the two charges. $\overrightarrow{F_{12}}=\frac{1}{4\pi\epsilon_o}\frac{q_1q_2}{r_{12}^2}\widehat{r_{12}}$ **Alternatively**	1 1	

	$\overrightarrow{F_{12}} = \frac{1}{4\pi \in_o} \frac{q_1 q_2}{r_{12}^{\;3}} \overrightarrow{r_{12}}$ Where $\overrightarrow{r_{12}}$ is a vector from charge q_2 to charge q_1.		
	ii) In derivation of Gauss's law, flux is calculated using Coulomb's law and surface area. Here coulomb's law involves $\frac{1}{r^2}$ factor and surface area involves r^2 factor. When product is taken, the two factors cancel out and flux becomes independent of r.	1	
	iii)  	½	
	$\vec{r} = \overrightarrow{AB} = a\hat{i} + a\,j$ r = $\lvert\overrightarrow{AB}\rvert = \sqrt{a^2 + a^2} = \sqrt{2}a$	½	
	$\vec{F} = \frac{1}{4\pi \in_o} \frac{q_1 q_2}{r^2} \hat{r}$ $\vec{F} = \frac{1}{4\pi \in_o} \times \frac{q \times 2q}{(\sqrt{2}a)^2} \times \frac{(a\hat{i} + a\,j)}{\sqrt{2}a}$	½	
	$\vec{F} = \frac{1}{4\pi \in_o} \times \frac{2q^2}{2a^2} \times \frac{(\hat{i} + j)}{\sqrt{2}}$ $\vec{F} = \frac{1}{4\pi \in_o} \times \frac{q^2}{\sqrt{2}a^2} \times (\hat{i} + j)$ $\vec{F} = \frac{q^2}{4\sqrt{2}\pi \in_o a^2} (\hat{i} + j)$	½	
	Note: Award 1 mark if a student calculates the magnitude of force only. $\lvert\vec{F}\rvert = \frac{1}{4\pi \in_o} \frac{q^2}{a^2}$		

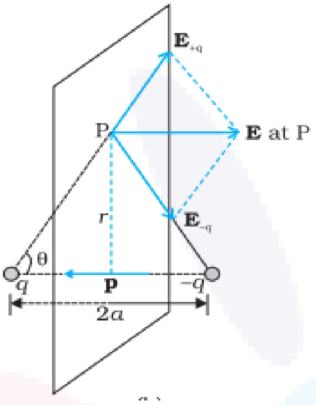
Alternatively
Give full credit if a student uses component method to solve the question.

OR

(b)

i) Derivation of electric field	2
ii) Effect on electric field	1
iii) Finding magnitude and direction of electric field	2

i)



½

$E_{+q} = \frac{q}{4\pi \in_o} \times \frac{1}{r^2+a^2}$

$E_{-q} = \frac{q}{4\pi \in_o} \times \frac{1}{r^2+a^2}$ ½

The components normal to dipole axis cancel away. The components along the dipole axis add up. ½

Total electric field is opposite to dipole moment.

$$\vec{E} = -(E_{+q} + E_{-q})\cos\theta\,\hat{p}$$

$$= \frac{-2qa}{4\pi \in_o (r^2+a^2)^{3/2}}\hat{p}$$

$$= \frac{-\vec{p}}{4\pi \in_o (r^2+a^2)^{3/2}}$$ ½

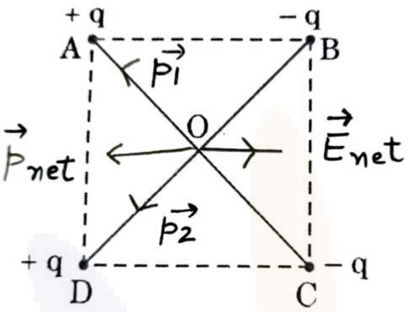
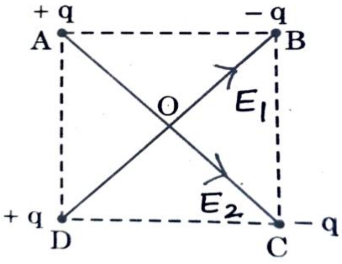
Deduct ½ mark if the expression of electric field is not in vector form.

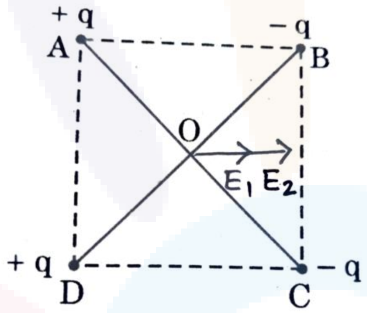
ii) At far off point r >> a

$$\vec{E} = \frac{-\vec{p}}{4\pi \in_o r^3}$$

When distance is halved.

$$\vec{E} = \frac{-\vec{p}}{4\pi \in_o (\frac{r}{2})^3}$$ ½

	$=\frac{-8\vec{p}}{4\pi\in_o r^3}$ $\vec{E}$ becomes 8 times	½	
	iii)  $p_1 = q\times 2Cm$ (along OA) $p_2 = q\times 2Cm$ (along OD)	½	
	$p_{net}=\sqrt{p_1^{\;2}+p_2^{\;2}}$ $=2\sqrt{2}\,qCm$ Electric field at centre O $E=\frac{kp_{net}}{(r^2+a^2)^{3/2}}$	½	
	at point O, r = 0 , a = 1 m	½	
	$E=\frac{k\times 2\sqrt{2}q}{1^3}$ $=2\sqrt{2}kq$ $=\frac{2\sqrt{2}q}{4\pi\in_o}$	½	
	Along DC **Alternatively**  E = $\frac{kq}{r^2}$ AC= BD= 2m r = OA =OB= OC=OD=1m Electric field at O due to charges at B and D $E_1 = E_B + E_D$		
	$E_1 = \frac{kq}{1^2}+\frac{kq}{1^2}$ along OB $= 2kq$ Electric field at O due to charges at A and C	½	

	$E_2 = E_A + E_C$ $E_2 = \frac{kq}{1^2}+\frac{kq}{1^2}$ $= 2kq$ along OC $E_{net} = \sqrt{E_1^{\ 2}+E_2^{\ 2}}$ $= 2\sqrt{2}$ kq $= \frac{2\sqrt{2}q}{4\pi \in_o}$ Along DC **Alternatively**  Considering AB as dipole, electric field at O $E_1 = \frac{2kq\times a}{((\frac{1}{\sqrt{2}})^2+(\frac{1}{\sqrt{2}})^2)^{3/2}} = \frac{2kqa}{(\frac{1}{2}+\frac{1}{2})^{3/2}} = 2kqa$ Similarly considering DC as another dipole, electric field at O $E_2 = \frac{2kq\times a}{((\frac{1}{\sqrt{2}})^2+(\frac{1}{\sqrt{2}})^2)^{3/2}} = \frac{2kqa}{(\frac{1}{2}+\frac{1}{2})^{3/2}} = 2kqa$ $E_{net} = E_1 + E_2 = 4kqa = \frac{1}{4\pi \in_o}\times 4\times\frac{1}{\sqrt{2}}\times q$ $= 2\sqrt{2}kq = \frac{2\sqrt{2}q}{4\pi \in_o}$ Along DC	½ ½ ½ ½ ½ ½ ½	5

33. (a)

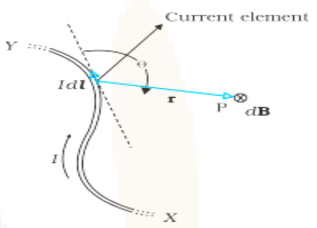
i) Statement of Biot-Savart's law	1
Expression for magnetic field	2
Diagram for magnetic field lines	½
ii) Finding current by revolving electron	1 ½

(i)

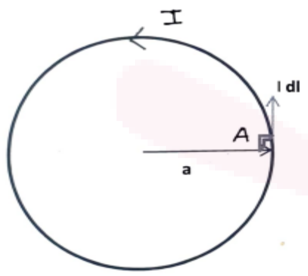
The magnetic field at a point due to a current carrying element is proportional to magnitude of current, element length and inversely proportional to the square of the distance from the element. 1

$$\vec{dB} = \frac{\mu_o}{4\pi} I \frac{\vec{dl} \times \vec{r}}{r^3}$$

$$|dB| = \frac{\mu_o}{4\pi} \frac{Idl \sin\theta}{r^2}$$



Consider a circular coil of radius a carrying current I.



½

According to Biot-Savart's law

$$|\vec{dB}| = \frac{\mu_o}{4\pi} \frac{Idl \sin\theta}{r^2}$$

At point A I $\vec{dl} \perp \vec{a}$

$\therefore \theta = 90^o, \sin 90^o = 1$ ½

Hence Db= $\frac{\mu_o}{4\pi} \frac{Idl}{a^2}$

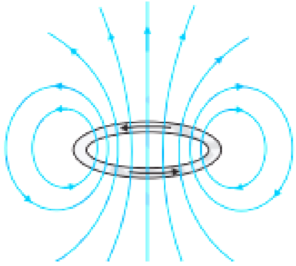
Magnetic field at centre

B= $\int_o^{2\pi a} dB = \int_0^{2\pi a} \frac{\mu_o}{4\pi} \frac{Idl}{a^2}$ ½

B= $\frac{\mu_o}{4\pi} \times \frac{I}{a^2} \times 2\pi a$

B = $\frac{\mu_o I}{2a}$ ½

Note: Give full credit of 2 marks if a student derives the expression for magnetic field at the axis of the loop and then puts distance of point as 0 from the centre.



½

ii) q=e , $v=10^7 ms^{-1}, r=10^{-10} m$

$i = \frac{q}{T}$

$= \frac{qv}{2\pi r}$ ½

$= \frac{ev}{2\pi r}$

$= \frac{1.6\times10^{-19}\times10^{7}}{2\times\pi\times10^{-10}}$ ½

$= \frac{0.8}{\pi}\times10^{-2} A$ ½

$= 0.255 \times10^{-2} A$ = 2.55 Ma

OR

b)

i) Derivation of expression for force	2
Statement of Rule	½
Conditions for maximum and minimum force	½ + ½
ii) Calculation of magnitude of force	1 ½

Consider a rod of uniform cross sectional area A and length *l*. Let the number density of mobile charge carriers in it be n. ½

Thus the total number of mobile charge carriers in it is n *l* A.

For steady current I, drift velocity of electrons $\vec{v_d}$, in the presence of external magnetic field $\vec{B}$, the force on these carriers is

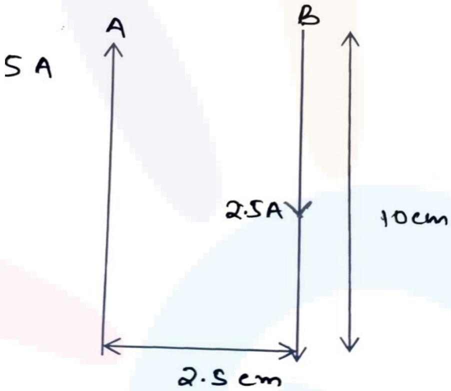
$\vec{F} = n\,l\,Aq(\vec{v_d}\times\vec{B})$ ½

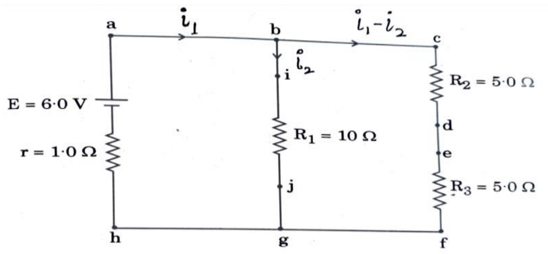
$= \left[\vec{j}Al\right]\times\vec{B}$ ½

$= I(\vec{l}\times\vec{B})$ ½

Where $nq\vec{v_d}$ is current density ($\vec{j}$) and $\left|\vec{j}A\right|$ is current (I)

Fleming's left hand Rule: If forefinger, middle finger and thumb are stretched in mutually perpendicular directions, such that forefinger indicates

	the direction of magnetic field, middle finger indicates the direction of current in the conductor, then thumb indicates the direction of force on the conductor. Or Right Hand Thumb Rule : If the fingers of right hand are made to rotate from $\vec{l}\ to\ \vec{B}$ through angle θ, the thumb points in the direction of force on the current carrying conductor. Condition for maximum force θ = 90^0 $\lvert\vec{F}\rvert = I\,l\,B\sin\theta$ = I l B Condition for minimum force $\theta = 0^o$ or 180^0 $\lvert\vec{F}\rvert = 0$ ii)  F= $\frac{\mu_o}{4\pi}\frac{2I_1I_2}{d}l$ = $\frac{10^{-7}\times2\times5\times2.5}{2.5\times10^{-2}}\times10\times10^{-2}N$ = 10^{-5} N	½ ½ ½ ½ ½ ½	5
	SECTION - E		
34.	a) Points at same potential 1 b) Current through arm bg 1 c) Potential difference across R_3 OR c) Power dissipated in R_2 2 a) Points (a, b, c) (d, e) (j, f, g ,h) are at same potential Note: Give full credit if a student mentions any two points at same potential from the above.	1	

<table>
<tr>
<td></td>
<td>b)


According to Kirchhoff's loop rule
for closed loop abgha
$- 6 + 10\ I_2 + I_1 = 0$
$I_1 + 10\ I_2 = 6$ (i)
for closed loop acfha
$- 6 + 10\ (I_1 – I_2) + I_1 = 0$
$11\ I_1 - 10\ I_2 = 6$ (ii)
Adding (i) and (ii)
$12\ I_1 = 12$
$I_1 = 1$ A
$I_2 = 0.5$ A
= current through arm bg
Note: Award 1 mark if a student calculates the current by any other method.

c) $V_{R3} = (I_1 - I_2) \times R_3$
$= 0.5 \times 5$
$= 2.5$ V
OR
(c) $P = (I_1 - I_2)^2 \times R_2 = (0.5)^2 \times 5$
$= 1.25$ W</td>
<td>½
½
1
1
1
1</td>
<td>4</td>
</tr>
<tr>
<td>35.</td>
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<table>
<tr><td>a) Tracing of path of ray</td><td>1</td></tr>
<tr><td>b) Finding velocity of light</td><td>1</td></tr>
<tr><td>c) Explanation of two application of TIR</td><td>2</td></tr>
<tr><td>OR</td><td></td></tr>
<tr><td>c) Definition of TIR</td><td>1</td></tr>
<tr><td>Mentioning two conditions of TIR</td><td>½ + ½</td></tr>
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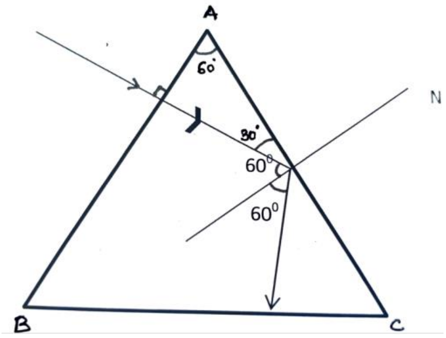
	a)  From fig. angle of incidence on second face $\angle i = 60^0$ critical angle $\angle i_c = 24.5^o$ $(\angle i) > (\angle i_c)$ ∴ TIR takes place	1	
	b) n= $\frac{c}{v}$ v = $\frac{c}{n} = \frac{3\times10^8}{2.41}$ = 1.24 × 10^8 m/s	1	
	c) Optical Fibre / Brilliance of diamond / mirage (any two) Note: Give full credit if students mention the names of applications only.	1+1	
	OR		
	c) When light travels from optically denser medium to rarer medium at an interface and gets reflected back into the same medium the phenomenon is called as total internal reflection.	1	
	Conditions for TIR 1. Light must travel from optically denser medium to rarer medium. 2. Angle of incidence at the interface must be greater than the critical angle for the pair of media.	½ + ½	4